Chapter 3
Description of the Proposed Action

The proposed action includes the construction of facilities, the operation of those facilities in concert with the existing CVP and SWP facilities and operations, the maintenance of the newly constructed facilities, and the conservation measures (CMs) and adaptive management that would be used to minimize effects and offset effects, including the measures that would be used to minimize effects during habitat restoration being proposed to offset the effects of construction and operations.

3.1 Design and Construction of the Proposed Facilities

There are a number of facilities that would be constructed as part of the proposed action. A detailed description of the construction activities associated with each is provided below.

Geotechnical exploration would be required to obtain data to support the development of an appropriate geologic model, characterize ground conditions, and reduce the geologic risks associated with the construction of proposed facilities. Exploration methods would include soil borings and conventional piezocones and seismic cones, as well as sampling for gas within soils and groundwater at selected locations.

3.1.1 Delta Intakes

3.1.1.1 Design

The proposed action would include construction of three new intakes (Intake 2, Intake 3, and Intake 5 [Figure 3-1]) on the east bank of the Sacramento River between Clarksburg and Courtland (see Table X for intake location features). Each intake would divert a maximum of 3,000 cubic feet per second (cfs). Each intake site would be approximately 1,800 feet by 1,500 feet (approximately 74 to 89 acres), and would consist of the following: a fish-screened intake structure that employs state-of-the-art on-bank fish screens; gravity collector box conduits extending through the levee to convey flow to the sedimentation system; a sedimentation system consisting of sedimentation basins to capture sand-sized sediment and drying lagoons for sediment drying and consolidation; a sedimentation afterbay providing the transition from the sedimentation basins to a shaft that would discharge into a tunnel leading to an intermediate forebay (IF); and an access road. In addition, a substation with transformers and switching equipment would be located at each intake site for electrical power supply, and a permanent parking area would be included for employee use during operations and maintenance. The general arrangement and design of the intake facilities are shown in Figure 3-2.

3.1.1.1.1 Intake and Fish Screen System

Each intake would consist of a reinforced concrete structure subdivided into individual bays that can be isolated and managed separately. Water would be diverted from the Sacramento River by gravity into the screened intake bays and routed from each bay through multiple parallel conveyance box conduits to the sedimentation basins. Flow meters and flow control sluice gates would be located on each box conduit to assure limitations on approach velocities and that flow balancing between the three intake facilities is achieved. Isolation drop gates allow for maintenance of the flow meters and flow-control sluice gates. All of the intakes would be sized at the design water surface elevation (WSE) to provide approach velocities at the fish screen of less than or equal to 0.20 feet per second (ft/s) at an intake flow rate of 3,000 cfs. The design water surface elevation (WSE) for each site was established as the 99 percent exceedance (Sacramento River stage) elevation, and the maximum design WSE was established as the 200-year flood elevation plus an 18-inch allowance for sea level rise (Table 3-1).

Table 3-1. Location Features of the Sacramento River Intakes

Intake	Location (approximate RM)	Length along Sacramento River bank (ft)	Elevation (ft [NAVD88])		
			Design WSE	200-Year Flood WSE with sea level rise	Average River Bottom Elevation
Intake 2	41.1	1,677	1.9	31.4	-14
Intake 3	39.4	1,259	1.6	30.4	-25
Intake 5	36.8	1,677	0.7	28.4	-14

Note:
RM = river mile
ft = feet
NAVD88 = North American Vertical Datum of 1988

The fish screen system would consist of screen panels and solid panels that form a barrier to prevent fish from being drawn into the intake and a traveling screen cleaning system. The fish screens would be designed to meet delta smelt criteria, which require 5 square feet/cfs and result in approach velocity less than or equal to 0.2 ft/s. When coupled with equal or less sweeping velocities, delta smelt impingement and screen contact is minimized (Swanson et al. 2005; White et al. 2010). The delta smelt screening criteria are also protective of salmonids, for which the standards for Chinook salmon fry are 0.33 ft/s approach velocity. The intake fish screens would be a vertical flat plate profile bar type in stainless steel with a maximum opening of 0.069 inches and porosity of 43 percent. Fish screens would be 12’6”H x 15’7”W, 17’0”H x 15’7”W, 12’6”H x 15’7”W at Intakes 2, 3, and 5, respectively. Screen panels would be installed in the lowest portion of the intake structure face, and solid panels would be stacked above them in guides extending above the deck of the structure. The screen panels would be arranged in groups, with each screen bay group providing sufficient screen area for 500 cfs of diversion. There would be six separate screen bay groups per intake facility, all of which would be hydraulically independent. Intake 2 and Intake 5 would each have 90 screen bays, and Intake 3 would have 66 screen bays (Figure 3-3). Design plans for Intakes 2, 3, and 5 are shown in Figures 3-4, 3-5, and 3-6, respectively. A log boom would protect the screens and screen cleaning systems from impact by large floating debris. Each screen bay group would have a dedicated traveling screen cleaning system. The screen cleaners would be supported by a monorail and driven by an electric motor and cable system with a cycle time of 5 minutes, maximum. Flow control baffles would be located behind each screen panel and would be installed in guides to accommodate complete removal of the baffle assembly for maintenance. These flow control baffles would be designed to evenly distribute the approach velocity to each screen such that it meets the guidelines developed by the Fish Facility Technical Team (FFTT) (FFTT 2011). The flow control baffle guides would also serve as guides for installing bulkhead gates (after removal of the flow control baffles) for maintenance of a screen bay group. The bulkhead gates would be designed to permit dewatering of a screen bay group under normal river conditions. A typical section of an intake, including associated fish screen panel, screen cleaner, log boom and other associated structures is shown in Figure 3-7.

Because of the length of the screens and extended fish exposure to their influence (screens and cleaners), fish refugia areas have been recommended to be incorporated into the screen design of the intakes (FFTT 2011). These areas would consist of small areas created within the columns between the fish screens that will provide small fish resting areas and protected cover from predators. Design concepts for fish refugia are still in their infancy and are usually site-specific, with designs recommended by the fish agencies (Svoboda 2013). Two recent examples of the refugia design and installation process include the Red Bluff fish screen and Reclamation District 2035, on the Sacramento River just north of Sacramento (Svoboda 2013). The Red Bluff fish screen design used a physical model study to assess hydraulic parameters such as velocity and turbulence in relation to behavior of juvenile Chinook salmon, white sturgeon, and rainbow trout. Bar spacing at the entrance to the refuge was selected based on fish size (to allow species for protection in, while excluding predators) and a final configuration was chosen to reduce velocity in the refuge while minimizing turbulence; a total of four fish refugia were constructed along 1,100 feet of screen. At the Reclamation District 2035 fish screen, an initial design included a single refuge pocket midway along the intake, which was subsequently modified to include 2-ft-long refugia between each screen panel along the intake. This fish screen also included juvenile fish habitat elements into the upstream and downstream sheet pile training walls and the sloped soil areas above the training walls, with grating materials attached to the sheet pile walls to prevent predatory fish from holding in the corrugated areas by the walls and to another form of refuge for small fish (Svoboda 2013). These two examples serve to illustrate the site-specific design considerations that are necessary for construction of large intakes.

All fish screen bay groups would be separated by piers with appropriate guides to allow for easy installation and removal of screen and solid panels as well as the flow control baffle system and bulkheads; these features would be removed from the deck by either a mobile or gantry crane (Figure 3-7). Piers would support the operating deck set with a freeboard of 18 inches above the 200-year flood level with sea level rise. The levee in the immediate area would be raised to provide a freeboard of 3 feet above the 200-year flood level with sea level rise. Sheet pile training walls would have a radius of 200 feet and would be upstream and downstream of the intake structures providing improved river hydraulics and vehicular access to the operating deck as well as transitioning the intake structure to the levee.

A common plenum area behind each screen bay group would collect and funnel the flow towards two reinforced concrete intake collector box conduits located at the back of each intake structure. The box conduits would extend through a widened levee section and terminate at the sedimentation basins. The flow rate in each box conduit would be controlled by a sluice gate downstream of drop gates at the beginning of the conduit channel (Figure 3-7). Each flow control sluice gate would be modulated by a dedicated flowmeter to allow for independent operation of each box conduit and maximum flexibility to vary flow within each fish screen bay and between each of the three intakes. The intake box conduits would include isolation drop gates that would be closed during periods of high river stage. The isolation drop gates would be manually installed using a side boom mobile crane. An emergency electrical power source (an engine-generator with a capacity of approximately 250 kilowatts) may be used to close the electrically actuated control gates during concurrent periods of high river stage and utility power outage. Gate closure is required by the U.S. Army Corps of Engineers (the Corps) and the Central Valley Flood Protection Board.

3.1.1.1.2 Sedimentation Basins and Drying Lagoons

Monthly and annual distributions of sediment data of the Sacramento River near Delta Habitat Conservation and Conveyance Program (DHCCP) intakes were analyzed and provide estimates of the sediment being diverted into the proposed DHCCP intakes. The amount and the distribution of the diverted sediments can be used in preliminary sizing of the sedimentation basins and possible methods of handling the sediment. The flow and suspended sediment data used in the study were taken from the Sacramento River Freeport gauging station monitored by the U.S. Geological Survey (USGS), USGS Station No.11447650. The suspended data includes the time period from 1956 through 2010. The grab sample data of the suspended sediment load for Freeport for selected days was taken from the USGS, 1983 study. The gradation curves of the bed load materials for Freeport was taken from the Northwest Hydraulic Consultants Inc. (NHC, 2003) study.

There is a large variation on the monthly sediment load of the Sacramento River and it closely follows the variation in the flow. The suspended sediment load is high during the wet months of December through February and low during the dry months of June through November. In California higher rainfall occurs during the months of December through February, during these months the flows from tributaries and watersheds join the main river without going through reservoirs. Since the flow from watersheds comes directly into the main channel, it will have higher amount of suspended sediments. Flows from major Sacramento River tributaries are captured by large reservoirs. The reservoirs not only impound water but also help to settle out the sediment carried by these tributaries. The majority of the Sacramento River flows during the summer months consist of releases from the upstream reservoirs which act as a sediment filter and lessen the downstream sediment loads.

The historical maximum sediment load of more than 71,400 tons per day corresponds to the flood event of 1964. Although the peak flow of 1964, 1986, and 1997 were comparable, the sediment load for the later years is far less than that of 1964 flood. This implies that the sediment concentration in the Sacramento River is guided by factors other than peak flow only. It may have to do with the construction and operation of the Oroville Reservoir as well. Thus, the peak sediment observed in 1964 is far from the rest of the data points and it can be considered as an outlier.

Table 3-2. Monthly variation of the Suspended Sediment Load in Sacramento River at Freeport (1957-2010)

Month	Suspended Sediment Load (tons/day)		
	Minimum	Maximum	Median (50th Percentile)
January	210	48,510	9,385

February	407	53,320	14,270
March	499	29,030	9,959
April	319	29,040	3,228
May	254	17,030	2,052
June	285	10,860	1,145
July	244	3,771	1,373
August	299	3,152	1,274
September	418	5,968	1,298
October	183	17,540	645
November	172	19,740	1,019
December	257	71,410	4,315

The sedimentation system at each intake would consist of a jetting system in the intake structure that would resuspend accumulated river sediment through the box conduits to two unlined (Figure 3-7), earthen sedimentation basins where it would settle out, and then on to four drying lagoons (Figure 3-8). The sediment jetting system, which would consist of a vertical turbine pump and associated piping, control valves, and spray nozzles, would be designed to run periodically. The sediment jetting pump would pressurize water from the pipe manifold located behind the back wall of the intake structure and deliver it to spray nozzles, which would spray the bay floor (Figure 3-9). The sedimentation basins would be triangular in shape and the maximum width of each half basin, measured at the intake channel along the floor, would be 677 feet for Intakes 2 and 5, and 575 feet for Intake 3, and the basin width at the outlet zone for all intakes would be 265 feet. Sedimentation basins at all intakes would be 660 feet long and 25 feet deep (for normal settling depth and sediment storage depth). The bottom of each basin would be at an elevation between -28 and -23 feet and the surrounding deck would be 3 feet above the WSE corresponding to a 200-year flood (inclusive of projected sea level rise). Sediment particles larger than 0.002 mm are expected to be retained (settle out) in the sedimentation basins, while particles smaller than 0.002 mm (i.e., colloidal particles) would flow through to the tunnel system to the intermediate forebay (IF). The basins would be divided by an earthen berm running the full length of the basin, Each drying lagoon would be approximately 160 feet wide (at the bottom), 350 feet long, and 15 feet deep with sloped sides. The top of each lagoon would be level with the site and would be protected from the design flood condition. Two drying lagoons would be available for each sedimentation basin allowing for a yearly rotation cycle with one drying lagoon filling and one settling and being dewatered through underdrains and a decant system.The vertical shafts that would be used for tunnel excavations at each of the intakes would be converted to outlet towers once tunnel construction is completed. There would be one outlet tower at each intake and it would be centrally located between the two sedimentation basins (Figure 3-8). Each outlet tower would consist of two sets of drop gates and each set would consist of four drop gates dedicated to each sedimentation basin. Each set of drop gates would receive flow from each sedimentation basin down to the tunnels. The outlet tower elevation is set above the 200-year flood level with sea level rise. The outlet gates would normally be open except during basin dredging or during the 200-year flood to avoid large sediments collecting in the tunnels.

At each intake site, a barge-mounted suction dredge would hydraulically dredge the sedimentation basins through a dedicated dredge discharge pipeline to 4 drying lagoons. Annual dredging of the sedimentation basins would be needed to maintain the basin efficiency and reduce the amount of settleable solids from being transported downstream. Less than 0.70 feet of sediment is expected to accumulate in an average year, with maximum annual depth estimated at about 1.5 feet per sedimentation basin.

A typical barge-mounted suction dredge used at the intakes would be the Dragon Model, Series 370 HP, Cutterhead Dredge, manufactured by Ellicott Dredges, LLC., 1425 Wicomico Street, Baltimore, Maryland 21230; or General will provide the necessary capacity for the handling the sediment at each intake and Clifton Court.

At each of the three intake sites each drying lagoon would be 160 feet wide at the bottom, 350 feet long and 15 feet deep. The tops of the lagoons would be level with the site. There would be two drying lagoons per one sedimentation basin. A yearly rotation cycle of lead/lag operation is used, with one drying lagoon filling and one settling and dewatered by underdrains and a manually operated decant system. Flow from the underdrains and decant system would be collected in an outlet structure and piped to the sedimentation basins. To prevent seepage, the drying lagoon would be constructed with roller-compacted concrete, and the side slopes would be lined with reinforced shotcrete or roller-compacted concrete. Each sedimentation basin can be dredged in one rotation. Access ramps into each drying lagoon would be provided for a front-end loader to load accumulated solids into a truck for disposal. The intake fish screens will be designed based on guidance provided by the FFTT report (FFTT 2011).

3.1.1.2 Construction

Construction activities for the water conveyance facilities would likely occur concurrently during several phases of construction, as shown in Appendix 3A. The final sequence of activities and duration of the schedule will depend upon the actual execution of the work, the contractor's actual means and methods, definition and variation of the design, abnormal conditions, and other variable factors. Therefore, a final schedule should be expected to vary from the preliminary schedule.

Preliminary construction-related tasks to facilitate construction of the intakes and other features of the water conveyance facilities would include mobilization, site work, and establishing concrete batch plants, pug mills, and cement storage areas. During mobilization the contractors would bring materials and equipment to construction sites, set up work areas, locate offices, staging and laydown areas, and secure temporary power. Site work would consist of clearing and grubbing, constructing site work pads, and defining and building construction access roads. To the greatest extent possible, existing levee roads, local roads, bridges, and highways would be used during construction of all water conveyance features. Staging, storage, and construction zone prep areas for each intake site would be approximately 5 to 10 acres.

Each intake has its own construction timeline with Intakes 2, 3 and 5 taking 3.8, 5.3 and 3.5 years respectively. This schedule includes the construction of the intake, road relocation, box culverts, sedimentation basin, building pad and control structure. . The proposed intakes would be sited along the existing levee system. Levee modifications would be required to facilitate intake construction and to provide continued flood management. The levee sections adjacent to the intakes would be widened by approximately 250 feet to increase the crest width, facilitate intake construction, provide a pad for sediment handling, and accommodate the permanent realignment of

State Route (SR) 160. To widen the levees, low permeability levee fill material (in accordance with USACE specifications) would be placed on the landside of the levee. The material would be compacted in lifts and keyed into the existing levee and ground. Ground improvement through jet grouting or other means would be provided to reduce the risk of liquefaction-induced settlement beneath the intake structure, box conduits, and pad fill area. Depending on foundation material, foundation improvements would require excavation and replacement of soil below the new levee footprint and potential ground improvement. The levees would be armored with riprap—small to large angular boulders—on the waterside. All construction and modifications will comply with applicable state and federal flood management, engineering and permitting requirements. The widened levee sections would allow for construction of the intake cofferdams, associated diaphragm walls, and levee cutoff walls within the existing levee prism while preserving a robust levee section to remain in place during construction. Some clearing and grubbing of levees would be required prior to installation of the sheet pile cofferdam at the intake sites, depending on site conditions (Figure 3-10). Site clearing and grubbing, work area limits, and site access to stockpile locations will be developed, along with the applicable security provisions such as security fences, gates, and/or cameras. Silt fencing and straw bale dikes may be installed, as needed, to address drainage issues, and dust abatement and other environmental concerns relating to stockpiles will also need to be addressed.

Site work consists of clearing and grubbing, constructing site work pads, and defining and building construction access roads. Before site work commences, the contractor implements erosion and sediment controls in accordance with SWPPP. Although DWR plans to utilize the existing levee roads, local roads, bridges, and highways during construction to the greatest extent possible, some new roads and bridges may be constructed to expedite construction activities and to minimize impact to existing commuters and the environment. Maintaining access roads and environmental controls will require enforcement of BMPs.

Except where crossing under a major waterway, intake conveyance pipelines will be installed via open cut. Excavation will include clearing, grubbing, excavation, disposal of excess spoil material and dewatering.

3.1.1.2.1 Cofferdam Construction

The cofferdam construction method is in two phases and allows in-water work to continue through the winter. In the first phase, cofferdam construction begins in August and lasts approximately 35 days, and the dewatered area is the project construction site for half of the operable barrier into the adjacent levee. The cofferdam is either removed or cut off at the required invert depth. In the second phase, the remaining half of the operable barrier is constructed using the same methods and incorporated into the final barrier layout, with the cofferdam either removed or cut off. Depending upon weather and river flow conditions, construction within the cofferdam continues until early November or throughout the winter.

Over water construction depends on the water level in the river. Construction occurs only during the low level season. Four-month window in the low water season (August 1 to October 31) for driving steel sheeting to construct a cofferdam, or performing any work activities in the water (e.g., excavation using a dragline). The slough needs to remain navigable during construction.

Inlet, Outlet, gates and control structures are constructed inside cofferdams. Sheetpile cofferdams are limited to 100 feet in width (front to back) for purposes of bracing.

The sheet pile portion of the cofferdam (river side of existing levee) and training walls for intake structure will be constructed by tying the cofferdam into the diaphragm wall constructed on the landside of the levee crest to provide an enclosed area for construction of the intake structure.

Each intake site would require a temporary cofferdam to create a dewatered construction area encompassing the entire intake site. The length of the temporary cofferdam at each intake site would vary depending on the alignment and intake but would range from 740 ft to 2,500 ft for the pipeline/tunnel alignment and modified pipeline/tunnel alignment, and 890 ft to 2,440 ft for the west alignment. The top of the sheet piles will align with approximate top of existing levee crown and the bottom of the sheet piles to be driven to a depth that achieves hydraulic cutoff, for an approximate total length of 145 ft with approximately 100 ft driven below ground. Sheet piles would be driven from within the river by cranes mounted on barges and temporary decks. Installation of steel sheet piles and/or king piles would require both impact and vibratory pile driving, depending on geotechnical conditions at the sites. Piles for cofferdam and log booms would be 85 feet (Intake 2), 60 feet (Intake 3), and 55 feet (Intake 5) long. Piles for the intake structures would be a maximum of 100 feet long at all intakes. The depth of water where piles will be driven will be approximately 16 feet at Intake 2, 27 feet at Intake 3, and 15 feet at Intake 5.

The in-river subsoil conditions adjacent to Intake 2 are generally a 13-to 21-foot-deep layer of very loose to loose sand at the river bottom, followed by a 3- to 9-foot-thick layer of very soft to very stiff silt. The silt layer was underlain by 29 to 32 feet of loose to medium dense granular material followed by 10 to 17 feet of dense to very dense granular material. Below the granular stratum, the borings encountered a 40- to 53-foot-thick layer of hard mixed fines. The five northern borings encountered a dense to very dense sandy layer below the fines.

The in-river subsoil conditions adjacent to Intake 3 are generally a 40-foot-deep layer of loose to medium dense sand, silty sand, gravel, and silt at the river bottom, followed by a 15-to 20-foot-thick layer of medium dense to dense sand and very stiff fines. This layer was underlain by 15 to 20 feet of dense to very dense sand. Below the dense to very dense sand, the borings encountered a 5 to 8-foot-thick layer of very stiff to hard fines underlain by a 3- to 5-foot-thick layer of very dense sand. A 4.5-foot-thick tephra layer was encountered beneath this very dense layer in one bore hole. The borings encountered a mixture of hard fines with some very dense sand layers to the depth of the borings.

The in-river subsoil conditions at Intake 5 are generally a 10- to 21-foot deep layer of medium dense sand at the river bottom. The medium dense sand was underlain by a 25- to 35-foot thick layer of soft to firm fines, followed by 10 feet of hard fines. The fines strata were underlain by 75 feet of very dense sand at one bore hole. In another bore hole, the soils were predominantly very soft to stiff sandy fines with a few thin layers of silty sand.

From 8 to 12 piles could be installed per day per intake site. Impact-driven piles could require approximately 700 strikes each. Sheet piles would be installed in two phases starting with a vibratory hammer and then switching to impact hammer if refusal were encountered before target depths. Therefore, the number of strikes resulting from this two-phased installation method could be substantially lower. The in-water area temporarily isolated inside the temporary cofferdam would vary by intake location, but would range from 0.2 to 5 acres. The distance between the face of the intake and the face of the cofferdam would depend on the foundation design and overall dimensions. It is assumed that the distance between the intake and the cofferdam would be between 10 and 35 ft. Stone bank protection (or riprap), if present, would be cleared prior to installing sheet piles.

Excavation within the intake structure cofferdam and installed diaphragm wall will include installing a dewatering system within the area enclosed by the cofferdam and dewatering the cofferdam.

Drilled casings and reinforced concrete piers beneath the intake structure will be constructed. A tremie seal will be installed within the cofferdam. A matrix of foundation piles, will be driven within the area enclosed by the cofferdam. The matrix will consist of between 450 and 800 piles, depending on intake length. The piles will be 24 in. diameter, and approximately 130 ft long and will be either cast-in-drilled-hole (CIDH) and/or steel pipe driven piles. 8 to 12 piles driven per site per day with up to an average of 700 strikes each for impact-driven piles.

This may be done before or after the cofferdam is dewatered. If it is done after the cofferdam is dewatered and the site is dry, conventional construction methods would be used within the cofferdam. If done in during dewatering operations and the site within the cofferdam is wet, a barge-mounted rig positioned outside of the cofferdam or a deckmounted pile driving rig located on decking over the top of the cofferdam would be required.

The intake structure within the cofferdam system will be constructed using backfill between existing/improved levee and training walls on the upstream and downstream sides of the intake structure. Soil improvements between the cofferdam diaphragm wall and any unimproved soils up to the slurry cutoff wall will be installed with Highway 160 relocation.

After intake construction is complete the cofferdam would be flooded and removed by underwater divers using torches or plasma cutters to trim the sheet piles at the finished grade/top of structural slab. A portion of the cofferdam would remain in place to facilitate dewatering as necessary for maintenance and repairs. Depending on the alternative and intake, permanent cofferdams would range in length from 1,220 to 3,360 linear ft, including sheet pile transitions. A log boom pile system aligned within the river alongside the intake structure to protect the fish screens and fish screen cleaning systems from being damaged by large floating debris and boats will also be constructed.

For a typical heavy combination wall (Arbed HZ975D ‐ 12/AZ18), a moment carrying capacity of 600 ft ‐ kips per foot of wall would be expected. This was approximately the wall section used for the Freeport Intake project cofferdam, which restrained approximately 45 feet of levee soils. This moment capacity can be increased to 950 ft ‐ kips per foot of wall by doubling the number of H ‐ sections using a HZ975 ‐ 24/AZ18 combination wall. An additional variation is the use of pipe piles with welded sheetpile interlocks. These pipes are typically manufactured in the United States and can accommodate U.S. ‐ sourced intermediate sheets, such as PZ ‐ 27 and PZ ‐ 35 sections. A 48 ‐ inch ‐ diameter pipe pile with a 0.75 ‐ inch ‐ thick wall spaced at 60 inches on center (with PZ ‐ 27 sheets between) would have a moment capacity of approximately 2,100 ft ‐ kips. This is substantially greater capacity than that of an HZ combination wall.

For the purpose of this preliminary evaluation, it is assumed that the intake cofferdam, constructed partially in the levee and partially in the river, can be divided in two sections longitudinally and braced laterally by heavy wall pipe struts. At the Freeport Intake project, pipe struts were used in a single span arrangement to support the river - side and land - side walls, separated by a distance of approximately 90 feet. At greater separation distances, such as those expected for the DHCCP intakes, it is assumed that an intermediate support wall is required. This intermediate wall also serves to divide the intake cofferdam longitudinally, allowing staged construction and backfilling of the header pipes before construction of the intake structural, which may be beneficial to the construction schedule.

A slurry cutoff wall would also be constructed around the perimeter of the construction area for the landside intake facilities (Figure 3-11). This slurry wall, which would be tied into the diaphragm wall at the levee, would be intended to help prevent river water from seeping through or under the levee during periods when deep excavations and associated dewatering are required on the landside. By constructing a slurry wall in conjunction with a diaphragm wall, the open-cut excavation portion of the work on the landside of the levee would be completely surrounded by cutoff walls, minimizing induced seepage from the river during and following construction.

A new perimeter berm would be constructed at each intake site, and the space enclosed by the existing levee and new perimeter berm would be backfilled up to the elevation of the top of the perimeter berm, creating a building pad for the intake structure. The perimeter berm would surround the sedimentation basins, outlet shaft, and storage buildings, and would be designed to provide the same level of flood protection as the levee at each intake site.

Intakes would be constructed using a steel sheet pile cofferdam in the river to create a dewatered construction area that would encompass the planned area of the intake structure. Installation of these piles would require both impact and vibratory pile drivers; piles would be driven using barge-mounted cranes and cranes mounted on temporary decks. Assumptions for pile driving for each intake are detailed in the following sections and in Appendix 3B. The cofferdam would lie approximately 10–35 feet from the footprint of the intake. Once each cofferdam is completed, the enclosed area would be excavated to the level of design subgrade using clam shell or long-reach backhoe before ground improvements and installation of foundation piles. The anticipated ground improvement methods may include jet grouting and deep soil mixing. The foundation construction would either be carried out by in-the-wet construction or conventional construction using dewatering methods. Electric-powered dewatering wells would be installed throughout the site. Diesel-powered standby power generator(s) would be used to power the dewatering pumps during power outages. A backup pump would be provided at every dewatering location with pumps. Dewatering pumping may occur 24 hours per day, 7 days per week, and would continue throughout intake construction. Water would be pumped out of the cofferdam and stored in sedimentation tanks at landside work areas. Groundwater removed with the dewatering system would ultimately be treated, as necessary, and discharged in surface waters under a National Pollutant Discharge Elimination System (NPDES) permit. Treatment of the removed groundwater could be done in several ways, including conditioning, flocculation, settlement/sedimentation, and/or processing at a package treatment plant. Construction area non-storm water with be handled and discharged as described above. In general, Construction area non-storm water with be handled and discharged in accordance with National Pollutant Discharge Elimination System (NPDES) general permit and Central Valley Regional Water Quality Control Board requirements. Location of construction area non-storm water discharge points will be determined at time of filing for coverage under the NPDES general permit or before start-up of discharge as appropriate. Additional information to be developed during design and the contractor will be required comply with permit requirements.

Prior to dewatering, USFWS and NMFS approved fish rescue and salvage plans would be developed and implemented, as necessary, for dewatering operations. Velocity dissipation facilities, such as rock or grouted riprap, would be used to reduce velocity/energy and prevent scour where dewatering discharges reenter the river.

Construction of the intake foundation would require that eithercast-in-drilled-hole (CIDH) or concrete-filled steel pipe foundation piles be installed to support the intake structures. CIDH piles are installed by drilling a shaft, installing rebar, and filling the shaft with concrete; no pile driving is necessary with CIDH methods. Use of concrete filled steel piles would involve vibratory or impact-driving hollow steel piles, and then filling them with concrete. For the purposes of analysis, it is assumed that up to 60 steel piles would be driven per day for the construction of each of the three intake structures. Foundation piles for all intakes would be 42-inches in diameter. An estimated pile length of 50 to 70 feet below the sediment basin invert would be required for the proposed steel pipe piles. In-the-wet foundation construction would require the foundation to be drilled using a barge-mounted drilling rig positioned outside of the cofferdam (or a deck-mounted drilling rig per the permit requirement). Pier casings would be advanced during drilling for the full depth of the holes. Tremie concrete would be placed on the entire enclosed area within the cofferdam after ground improvement and the foundation drilling, reinforcement placement, and pier concrete placement are completed. The thickness of the tremie concrete would be commensurate with the design uplift pressure and the uplift capacity of the drilled piers. A 5-foot-thick slab has been used in the conceptual design. Once the tremie slab has cured sufficiently, unwatering of the cofferdam would then proceed to allow other construction activities to be carried out in the dry.

Minor channel work would be necessary to install the fish screens. Channel work would include grubbing and clearing within the area of the effect identified for the intakes. Foundation type, dimensions, and construction methods would be revised further when additional site-specific subsurface geotechnical data becomes available.

Intake 2

Intake 2 is located within the Sacramento River at the river-side toe of the existing east bank levee at river mile 41.1. Intake 2 would require approximately 1.120 piles. Channel disturbance area, as a result of the fish screen installment, for Intake 2 would range from approximately 3-5.5 acres.

Intake 3

Intake 3 is located within the Sacramento River at the river-side toe of the existing east bank levee at river mile 39.4. Intake 3 would require approximately 850 piles. Channel disturbance area, as a result of the fish screen installment, for Intake 3 would range from approximately 3-5.2 acres.

Intake 5

Intake 5 is located within the Sacramento River at the river-side toe of the existing east bank levee at river mile 36.8. Intake 5 would require approximately 1,120 piles. Channel disturbance area, as a result of the fish screen installment, for Intake 5 would range from approximately 3.7-6.4 acres.

Twelve, reinforced concrete box conduits (Figure 3-12) would be constructed across the back wall of the fish screens at each intake and would convey flows by gravity from the intake structure through the levee to the sedimentation basins. There would be two box conduits for each fish screen bay group. Each box conduits would have a height and width of 12 feet. Flow meters and flow control sluice gates located on each box conduit would ensure that approach velocity standards are met. The length of each box conduit would be approximately 375 feet, which would allow for construction of a permanent relocation of SR 160 as part of the initial construction phase at the intake sites.

Intake conveyance pipelines would be installed via an open-cut excavation. All existing vegetation and trees would be cleared and grubbed along the pipeline easements and would be disposed of offsite.

All in-water construction activities are expected to be restricted to the period between August 1 and October 31, when the potential for fish and aquatic species of concern to be present would be at a minimum. Delta smelt could be present at low abundance in the north, east, and south Delta during the period when in-water construction activity would occur, indicating some potential for exposure. Adults, which complete their spawning cycle and die by mid- to late June, could be exposed to pile driving noise following the onset of in-water pile driving in June. If a portion of the population spawns upstream of the construction areas, larvae could potentially drift through the areas affected by underwater sound. Thus, the potential exists for small numbers of spawning adults (during June) or larval delta smelt (during June and July) to occur in the vicinity of the intakes and the barge landings during the in-water construction period. With implementation of proposed timing restrictions on in-water pile driving activities (August 1 through October 31) and the use of vibratory pile driving methods whenever feasible, potential injury or mortality of delta smelt from pile driving noise is expected to be minimal and unlikely to have significant population-level effects. Additional construction timing restrictions could also be imposed by the relevant permitting agencies, to protect specific species. No additional in-water work would be conducted for construction of the intakes until the cofferdam is removed and rock protection is installed during the in-water work window. In-water work would not occur every season over the duration of construction. Activities occurring within a dewatered cofferdam are not considered “in-water work” for the purposes of these restrictions.

After construction of an intake structure is complete, the cofferdam would be flooded by removing the sheet pile walls in front of the intake structure. The removal of sheet pile walls would be performed by underwater divers using torches or plasma cutters to trim at the intake structure slab. Rock protection would be installed along the river banks upstream and downstream and along the front of the intakes to protect the intakes, prevent bank and channel erosion, and provide a transition from the river bottom to the intake structure. The length of bank protection required on either side of the intake would vary by intake location but would range from approximately 100 to 2,200 feet for the pipeline/tunnel, modified pipeline/tunnel, and east alignments, and from 500 to 1,800 feet for the west alignment. The intake structures and associated bank protection would permanently change existing substrates and local hydraulic conditions in the immediate vicinity of the intakes. . Construction work areas for the proposed intakes as well as for the other water conveyance features described in subsequent sections, would include areas for construction equipment and worker parking, field offices, a warehouse, maintenance shops, equipment and materials laydown and storage, reusable tunnel material (RTM [described in Section 3.1.2 *Conveyance Facilities*]) storage areas, and spoils stockpiles.

3.1.1.2.2 Concrete Batch Plants

Each construction site would also include some combination of required processing operations including temporary concrete batch plants, pug mills, soil mixing facilities, and cement storage. Specific locations have been identified for the proposed six concrete batch plants and six fuel stations. There would be a 1-acre concrete batch plant and a 1-acre fuel station at each of the three proposed intakes; a 38-acre concrete batch plant and 1-acre fuel station near Twin Cities Road and Interstate 5; a 30-acre concrete batch plant and a 1-acre fuel station in the center of Bouldin Island; and a 40-acre concrete batch plant and 1-acre fuel station between Byron Highway and Italian Slough. Batch plants, along with fine and coarse aggregate stockpiles, would produce concrete needed for various structures. Pug mills would be provided for roller compacted concrete and other soil materials. Soil mixing facilities may be required for some aspects of RTM disposal and for ground improvement activities. Cement and other materials would be stored at each site, as needed, to support concrete production, slurry wall construction, ground improvement, soil mixing, and other activities. Material stockpiles, tunnel segment storage areas, and handling areas would support the concrete and soil processing features described above. Other features with substantial earthwork components would require onsite material processing.

3.1.2 Conveyance Facilities

3.1.2.1 Design

The proposed conveyance tunnels are approximately 44 miles long from the proposed intake facilities to the exporting pumping plants. The conveyance includes three Intake Facilities with in-river intake structures and sedimentation basins; the North Tunnels, which consist of three reaches totaling approximately 14 miles that connect the Intake Facilities to the IF; two parallel Main Tunnels, each approximately 30 miles long; an IF; a pumping plant located adjacent to Clifton Court Forebay; and the North Clifton Court and South Clifton Court Forebays.

The North Tunnels from Intake 2 to a junction structure near Intake 3 and from Intake 5 to IF are single-bore, 28-foot inside diameter (ID) tunnels. The North Tunnel connecting the junction structure near Intake 3 to the IF is a single-bore, 40-foot inside diameter (ID) tunnel. Due to the lack of geological and topographical information, the diameters of these tunnels are preliminary and will be optimized during the final design phase of the project (Figure 3-13).

The water conveyance tunnels would be operated with a gravity feed system rather than with an intermediate pumping plant and an optional gravity bypass system at the outlet of the IF. The main construction or launching shafts for each tunnel would be 113 feet in diameter to accommodate construction and construction support operations. The tunnel boring machine (TBM) retrieval shaft would be 100 feet in diameter, and an intermediate access shaft 85 feet in diameter would be located along each tunnel drive to allow the contractor to make repairs to the TBM prior to completion of that tunnel drive. Each tunnel would also include a vertical drop shaft at the tunnel's upstream end, and a vertical rising shaft at the downstream end. Each tunnel reach would include at least one launch shaft, intermediate shaft and retrieval shaft per bore, except the tunnel between Intake 2 and Intake 3.

3.1.2.1.1 Reach 1: Intake 2 to Intake 3

Reach 1 starts at Intake 2 and ends with the junction structure at Intake 3. Intake 2 is on the east side of the Sacramento River, 1 mile south of Clarksburg and approximately 1.5 miles west of Interstate 5 (I-5). Water is diverted from the Sacramento River into Intake 2 and then flows toward the east through a 28-foot ID tunnel. This 28-foot ID tunnel extends approximately 2 miles from the tunnel access shaft to the junction structure at Intake 3.

3.1.2.1.2 Reach 2: Intake 3 to Intermediate Forebay

Reach 2 begins at Intake 3 and ends with the IF inlet shaft. Intake 3 is on the east side of the Sacramento River, 1.5 miles south of the town of Hood and approximately 3 miles west of I-5. This facility conveys the water directly into the junction structure. From the junction structure, a 40-foot ID tunnel extends approximately 6.74 miles south the the inlet shaft at the IF on Glanville Tract.

3.1.2.1.3 Reach 3: Intake 5 to Intermediate Forebay

Reach 3 begins at Intake 5 and ends with an IF inlet shaft. Intake 5 is on the east side of the Sacramento River, 1.5 miles south of the town of Hood, and approximately 3 miles west of I-5. This facility conveys water into a 28-foot ID tunnel that extends approximately 4.77 miles south to an IF inlet shaft at the IF of Glanville Tract.

3.1.2.1.4 Reach 4: Intermediate Forebay to Staten Island

Reach 4 starts on the Glanville Tract adjacent to the IF and is comprised of the northernmost 9.17 miles of the twin bore 40-foot ID tunnels from the IF to Staten Island. Reach 4 ends at the construction shafts on Staten Island, approximately 2 miles southeast of the community of Walnut Grove and just east of the Sacramento River.

3.1.2.1.5 Reach 5: Staten Island to Bouldin Island

In Reach 5, the main tunnels extend approximately 3.83 miles nearly due south from the Staten Island construction shafts to construction shafts immediately north of Potato Slough and south of Highway 12 (SR-12) on Bouldin Island.

3.1.2.1.6 Reach 6: Bouldin Island to Bacon Island

In Reach 6, the main tunnels extend approximately 8.86 miles nearly due south from the Bouldin Island shafts to reception shafts about 1.8 miles south of the Old River Connection Slough on Bacon Island.

3.1.2.1.7 Reach 7: Bacon Island to Northern Clifton Court Forebay (NCCF)

Reach 7, approximately 8.29 miles long, is the final section of the main tunnels. Drive shafts are just outside the northeast corner of CCF at the southern portion of Byron Tract in Reclamation District 800.

3.1.2.1.8 Reach 8: North Clifton Court Forebay (NCCF) and Connection to State Water Project and Central Valley Project

Reach 8 starts at the outlet structure from NCCF. It includes, under the existing CCF outlet, the inlet structure from the NCCF into a siphon structure to the new approach channel. This channel enters siphons underneath the Southern Pacific Railroad (SPRR) and Byron Highway that connect to another length of new approach channel that, in turn, connects to outlet control structures into the Banks PP and Jones PP. It also includes an emergency spillway for the NCCF and the divider embankment separating NCCF from South Clifton Court Forebay (SCCF). This reach encompasses the SCCF, a combination of the existing CCF and land south of and adjacent to CCF; and the control structures of the existing approach channels that isolate South Delta flows from MPTO/CCO flows to the export pumping plants.

The finished sizes of the respective shafts at Intakes 2, 3, 5, and the IF would match the diameter of the adjoining tunnel segments. These shafts would accommodate hydraulic functionality and provide access for maintenance and repair during operation of the water conveyance facilities. Access shafts associated with Tunnels 1a and 1b would be between 75–85 feet in diameter and would be backfilled following tunnel construction. The finished sizes of the main shafts associated with Tunnel 2 would be a minimum of 20 feet to allow for ongoing operation and maintenance. The permanent pad for each tunnel shaft would require protection against flooding. Aside from the pump shafts adjacent to the CCF – that will house the pump wet well, pump intakes, and the pumps themselves –, the finished shaft area pad elevations would be approximately 32 to 34 feet above mean sea level (msl).).

3.1.2.2 Construction

The proposed tunnels are anticipated to be constructed in soft, alluvial soils with high groundwater pressures. Because of this, the tunnels would be constructed using mechanized soft ground tunneling machines. The tunnels would be constructed at depths greater than 60 feet using mechanized closed-face pressurized tunneling machines in alluvial soils. Each tunnel would require appropriately sized TBM launching and retrieval shafts to accommodate equipment. If dense gravels, cobbles, or boulders are encountered in the older alluvium at depth, other mining methods may be utilized, such as grouting, jet grouting, use of a slurry TBM, or freezing and hand mining. Tunnels would be lined with precast concrete bolted-and-gasketed segments. The tunnel concrete liner would serve as permanent ground support and would be installed immediately behind the TBM, forming a continuous watertight vessel.

All tunnel shaft locations may also require dewatering activities, which would be implemented in a similar manner to dewatering for the construction of intake facilities, as described above. Dewatering systems would be designed and operated to control seepage pressures in the vicinity of the main bore and the vertical shafts to ensure that excavations remain stable. Discharge water would be conveyed to aboveground treatment facilities to comply with permit conditions before being discharged into the river. A diesel-powered train would transport construction workers through the tunnel during construction.

Access to the TBM cutterhead would be required for equipment inspection and/or maintenance purposes. Such maintenance work or "interventions" can be performed under pressurized conditions from within the TBM (referred to as "pressurized safe haven interventions"), and some work can be better performed in "free air" or atmospheric conditions (referred to as "atmospheric safe haven interventions"). In either case, this work would be performed in discrete areas along the tunnel alignments. The atmospheric interventions would occur at pre-planned locations along the tunnel alignments. With the current understanding of the geotechnical conditions in the action area, atmospheric interventions are planned at two-mile intervals on the alignments. The preliminary locations of these planned atmospheric interventions are shown in Figures 3-14 through 3-29 and are presented as either "vent shaft" locations or "safe haven work areas." The precise locations of the unplanned pressurized safe haven intervention areas have not yet been determined because the locations would depend on site-specific mining conditions and, therefore, these sites are not shown on mapbook figures. Pressurized safe haven interventions could be situated at intervals of 2,000 feet along the tunnel alignment, depending on the specific geology encountered by the TBMs.

Land disturbance activities at each of the intervention sites would differ depending on the type of intervention that is being executed. To the greatest extent possible, intervention sites would be located to avoid sensitive terrestrial and aquatic habitats. In the event these areas cannot be avoided, impacts will be minimized to the greatest extent possible. The pressurized safe haven work site would be limited to a surface area no larger than 1 acre. These safe haven intervention sites would be constructed by injecting grout from the surface to a point in front of the TBM, or by using other ground improvement techniques including ground freezing or installing dewatering wells to depressurize the ground around the TBM. Once the ground has been stabilized by one of these techniques, the TBM would then bore into the treated area. The purpose of treating an intervention site in one of these manners is to allow access to the cutterhead so that workers can either eliminate the need for working in hyperbaric conditions, or greatly reduce the pressures inside the cutterhead while maintenance work is being performed, which would greatly increase the speed and efficiency of the maintenance work. Surface equipment required to construct the safe haven intervention site would include a small drill rig and grout mixing and injection equipment, and facilities to control groundwater runoff at the site. The surface drilling and treatment operation would typically take about eight weeks to complete. Once complete, all equipment would be removed and the surface features reestablished. To the greatest extent possible, established roadways would be used to access the intervention sites. If access is not readily available, temporary access roads would be established.

Atmospheric safe haven interventions would occur at either 1) the identified tunnel vent shaft sites which become permanent features after construction is completed, or at 2) temporary small-diameter shafts that are used only during the tunnel construction work (those areas identified as "safe haven work areas" in Figures 3-14 through 3-29. The location and size of the permanent vent shaft work areas are shown on the figures. For the safe haven work areas, a small shaft, roughly equal to the diameter of the TBM cutterhead, would be excavated to tunnel depth at the approximate locations shown in Figures 3-14 through 3-29. The exact location of these shafts would depend on the specific tunneling conditions that are encountered. Approximately three acres would be required at each of these locations to set up equipment, construct flood protection facilities, excavate/construct the shaft, and set up and maintain the equipment necessary for the TBM maintenance work. It is anticipated that all work associated with developing and maintaining these shafts would occur over approximately 9 to 12 months. At the completion of the TBM maintenance at these sites, the TBM would mine forward, erect segments, and the shaft location would be backfilled to preexisting conditions.

Because the need for TBM maintenance or emergency access is dependent on the condition of the cutting face, the number and locations of intervention sites (either pressurized sites or atmospheric sites) are not known. Impacts from construction of either type of intervention site will be minimized or avoided by locating the work on disturbed sites either associated with construction of the tunnel or other activities or agricultural lands used to grow lower value crops. Discharge of drilling muds or other materials required for drilling and grouting would be confined to the work site and would be disposed of offsite at a permitted facility. Disturbed areas would be returned to preconstruction conditions by careful grading, reconstruction of features such as irrigation and drainage facilities, and replanting of crops and/or compensating farmers for crop losses.

During construction, all shaft locations would be protected from flooding caused by failure of a levee. This protection would be achieved by constructing a raised earthen pad at each shaft site (or by use of another suitable method). The size of the pad would vary from site to site, depending on specific location conditions. It is anticipated that the height of the shaft protection pads would be at the 100-year design flood elevation for each island. After construction of the tunnels, the launching and retrieval shafts would be backfilled around steel pipes or formed concrete pipes, or would be cast against reusable forms to the required finished diameter and geometry. The intermediate shafts would be excavated using conventional augers and would be supported using steel casings. The shafts would be drilled to below the tunnel invert elevation before the boring machine reaches the shaft stationing.

Two culvert siphons would be constructed. One would connect the north cell of the expanded CCF to a new approach canal to the Banks and Jones Pumping Plants under the existing CCF outlet channel, and one would connect the new approach canal to the existing approach canal to Banks Pumping Plant under Byron Highway and the Southern Pacific Railroad. At this proposed siphon location, a segment of Byron Highway and the Southern Pacific Railroad would be temporarily rerouted to accommodate construction of the siphon. Cofferdams would be used to construct the outlet siphon from the north cell of CCF, and shoring would be used to construct the siphon in a single phase under Byron Highway and the Southern Pacific Railroad, requiring temporary realignment of these features during construction.

Construction staging areas would include space for offices, parking, maintenance shops, segment storage, fan line storage, daily spoils, power supply, water treatment, and other space requirements. Depending on the method selected to construct the walls for the tunnel shafts, the staging areas may also include space for the slurry ponds required for slurry wall construction. Work areas for RTM handling and spoils storage would also be necessary.

3.1.2.2.1 Reusable Tunnel Material

RTM is the by-product of tunnel excavation using a TBM. The RTM would be a plasticized mix consisting of soil cuttings, air, water, and may also include soil conditioning agents. Soil conditioning agents such as foams, polymers, and bentonite may be used to make soils more suitable for excavation by a TBM. Modern soil conditioners are non-toxic and are biodegradable. Before the RTM can be reused or disposed of, it must be managed and, at a minimum, go through a drying process. Additional RTM processing, beyond the conventional atmospheric drying process, would be implemented if deemed necessary to comply with regulatory requirements.

During tunnel construction the daily volume of RTM that would be withdrawn at any one shaft location would vary, with an average volume of approximately 6,000 cubic yards per day. It is assumed that the transport of the RTM out of the tunnels and to the RTM storage sites would be nearly continuous during mining or advancement of the TBM. The RTM would be carried on a conveyor belt from the TBM to the base of the launching shaft. The RTM would be withdrawn from the tunnel shaft with a vertical conveyor and placed directly into the RTM work area using another conveyor belt system. From the RTM work area, the RTM would be rough segregated for transport to RTM storage and water treatment (if required) areas as appropriate. RTM would be transported and deposited via conveyor and/or truck to designated RTM storage areas. It is assumed that RTM would be stacked to a height of 10 feet and that storage areas would be located adjacent to main tunnel shafts (Figures 3-14, 3-15, 3-18 through 3-21, and 3-24 through 3-26 , Figure 3-30, Figures 3-31 through 3-47, and Figures 3-48 through Figure 3-53).

Approximately 30.7 million cubic yards of RTM would be excavated during construction of the tunnel conveyance. At the southernmost launch shaft at the northeast corner of the CCF, a conveyor would move the RTM westward to Italian Slough. At Italian Slough a trenchless crossing would be constructed to transport the RTM under the slough to the RTM storage area on Byron Tract. The trenchless crossing would consist of a small diameter pipe (approximately 72 inches in diameter) and its construction would entail microtunneling or pipe jacking under Italian Slough. Once the pipe is in place, an electric conveyor belt would be installed in the pipe. Once construction of the water conveyance structure has been completed, this pipe would be backfilled with concrete.

Approximately 2,600 acres would be allocated for storage of RTM and spoils from dredging the CCF. This area also includes land that would be required for access roads, staging and laydown areas, and other ancillary facilities required for the processing and storage of RTM. Therefore, the area required for storage of the material itself would be approximately 1,208acres. It is assumed that RTM and dredged material would be stacked to a height of 6-10 feet at storage areas (except at sites adjacent to the north of the CCF and on Glannvale Tract, where material would be stacked to a height of 10–15 feet) and that storage areas would be located adjacent to tunnel shafts, including sites just northeast of Intake 2, several parcels west of Interstate 5 near the IF, on southeastern Bouldin Island, and on Byron Tract west of the CCF. Once the RTM is removed from the tunnel, it must be suitably dewatered prior to final long-term storage or reuse. Atmospheric drying by tilling and rotating the material, combined with subsurface collection of excess liquids is typically sufficient to render the material dry and suitable for long-term storage or reuse. Leachate would drain from ponds to a leachate collection system, then pumped to leachate ponds for possible additional treatment. Disposal of the RTM decant liquids would require permitting in accordance with NPDES and Regional Water Quality Control Board regulations. It is assumed that a retaining dike and underdrain liquid collection system (composed of a berm of compacted soil, gravel and collection piping, as described below), would be built at the RTM storage area(s). The purpose of this berm and collection system would be to contain any liquid runoff from the drying material. The berm geometry would conform to applicable design guidelines and standards. Based on the soil properties, the volume of material to be processed, and the size of the material storage area, the area may be subdivided into a system of dewatering or processing areas. The dewatering process would consist of surface evaporation and draining through a drainage blanket consisting of rock, gravel, or other porous drain material. The drainage system would be designed per applicable permit requirements. Treatment of liquids (primarily water) extracted from the material could be done in several ways, including conditioning, flocculation, settlement/sedimentation, and/or processing at a package treatment plant to ensure compliance with discharge requirements.

Once the RTM has been suitably dewatered, and depending on the constituents of the material, the RTM would be placed in either a lined or unlined storage area, suitable for long-term storage. These long-term storage areas may be the same area in which the material was previously dewatered or it may be a new site adjacent to the dewatering site. The storage areas would be created by excavating and stockpiling the native topsoil for future reuse. Once the area has been suitably excavated, and if a lined storage area is required, an impervious liner would be placed on the invert of the material storage area and along the interior slopes of the berms surrounding the pond. Due to the expected high groundwater tables, it is anticipated that there would be minimal excavation for construction of the long-term material storage areas. Additional features of the long-term material storage areas would include berms and erosion protection measures to contain storm runoff if necessary and provisions to allow for truck traffic during construction, as appropriate.

Depending on the type of soil removed through tunneling, the type of soil conditioners added, and the material management and water treatment processes required, RTM may be reused locally (e.g., for levee reinforcement or as fill material in support of restoration activities). Dried material that is not reused may be graded, covered with previously-stockpiled topsoil, and seeded for vegetation. RTM would be tested per applicable standards and assessed for usability prior to reuse.

Excess excavated material from NCCF and SCCF areas will be disposed of in an adjacent common disposal/borrow area on Byron Tract, northwest of NCCF, between Byron Highway and Italian Slough. Unsuitable excess excavated material at the northern MPTO/CCO facility sites (Intake Facilities, North Tunnels, and IF) will be disposed in the designated RTM disposal area near or at the IF. Suitable materials may be reused for the fill pads of the Intake Facilities.

Table 3-3. Tunnel Shaft Site Pad Fill Area and RTM Disposal Acreage for North and Main Tunnels

Site	Work Area Site Pad Fill Volume (cy)	In-Place RTM Volume (cy)	RTM Disposal and Top Soil Storage Area[a,b] Site (acres)
North Tunnel Shaft - Intake 2 (RTM and launch shaft)	188,000	514,976	53
North Tunnel Shaft –Intake 3 (Junction Structure\ Reception Shaft)	(Intake 3 fill pad)	-	-
North Tunnel Shaft –Intake 5 (Reception Shaft)	(Intake 5 fill pad)	-	-
IF : North Tunnel and Main Tunnel (RTM and Launch shafts)	(not required)	3,918,464	405
Staten Island Reception Shafts	429,000	-	-
Bouldin Island Launch Shafts	640,000	11,701,184	1,209
Bacon Island Reception Shafts	141,000	-	-
Clifton Court Forebay Launch Shaft and CCF Dredge Material	407,300[c]	14,568,400	903[d]
Totals	3,051,300	30,703,024	-

[a] Assumed 1 foot of topsoil stripped and stored.
[b] Disposal areas filled 6 feet high for all sites except for CCF, which will be 10-feet high.
[c] Fill pad volume is for CCF launch shaft.
[d] Assumed no topsoil storage area for CCF dredge material.

Treated water from RTM could be reclaimed, discharged, or disposed according to NPDES and other applicable codes and regulations. A study conducted by DWR (URS 2014) consisted of mixing native soil samples collected from the potential tunnel zone with representative soil conditioner products and conducting laboratory tests to measure the following qualities of RTM:

- Geotechnical properties to evaluate constructability if used as structural fill,
- Environmental properties to characterize potential toxicity if placed in the environment, and
- Planting suitability to assess sustainability for habitat growth and agricultural use.

While the study consisted of a limited number of samples and tests, and does not constitute a complete evaluation of RTM, based on the results of the geotechnical, environmental, and planting suitability tests, DWR concluded that RTM appears to be suitable for the above proposed beneficial uses following storage and drying. The contractor would need to chemically characterize RTM and associated decant liquid prior to reuse or discharge. Consultation with governing regulatory agencies would be required to obtain the necessary approvals and permits. While it appears that at least some RTM may be suitable for various means of reuse, to provide for a worst-case analysis with respect to the areal impact of proposed RTM storage, it is assumed that all RTM storage areas would be permanent, and that RTM would not be removed and reused from these sites.

3.1.3 Head of Old River Operable Barrier

3.1.3.1 Design

An operable barrier at the head of Old River would be constructed to support operations of the proposed action. This control structure is intended to prevent migrating and outmigrating salmon from entering Old River from the San Joaquin River, and thereby minimizing exposure to the SWP and CVP pumping facilities. The barrier would be located at the divergence of the head of Old River and the San Joaquin River and would be approximately 210 feet long and 30 feet wide, with top elevation of 15 feet msl (NAVD 88). This structure would include seven bottom-hinged gates, totaling approximately 125 feet in length. Other components associated with this barrier are a fish passage structure, a boat lock, a control building, a boat lock operator's building, and a communications antenna. Appurtenant components include floating and pile-supported warning signs, water level recorders, and navigation lights. The barrier would also have a permanent storage area (180 by 60 feet) for equipment and operator parking. Fencing and gates would control access to the structure. A communications antenna for telephone and telemetered data transmission would also be constructed, and a propane tank would supply emergency power backup.

The boat lock would be 20 feet wide and 70 feet long and would have floating boat docks for temporary mooring, navigation signs and lights, warning signs, and video surveillance capability. The fishway would be designed according to guidelines established by NMFS and USFWS for several species including salmon, steelhead, and green sturgeon. The fishway would be approximately 40 feet long and 10 feet wide and would be constructed with reinforced concrete. Stoplogs would be used to close the fishway during the spring when not in use to protect it from damage.

When the gate is partially closed, flow would pass through the fishway traversing a series of baffles.

The fishway is designed to maintain a 1-foot-maximum head differential across each set of baffles. The historical maximum head differential across the gate is 4 feet; therefore, four sets of baffles are required. The vertical slot fishway is entirely self-regulating and operates without mechanical adjustments to maintain an equal head drop through each set of baffles regardless of varying upstream and downstream water surface elevations.

3.1.3.2 Construction

The head of Old River barrier would be constructed using one of two methods: (1) cofferdam construction, which creates a dewatered construction area for ease of access and egress; and (2) in-the-wet construction, which allows the river to flow unimpeded and eliminates the time, material, and cost of constructing a cofferdam. For the purposes of analysis, it was assumed that the cofferdam construction method would be chosen. Regardless of which construction method is chosen, standard avoidance and minimization measures would be implemented to minimize effects (See Table 3-6). To ensure the stability of the levee, a sheetpile retaining wall would be installed in the levee where the gate would be constructed. All in-water work, including the construction of cofferdams, sheetpile walls and pile foundations, placing rock bedding and stone slope protection, and dredging, would occur between August 1 and October 31 to minimize effects on delta smelt and juvenile salmonids. All other construction would take place from a barge or from the levee crown and would occur throughout the year.

The construction of the cofferdam and the foundation for the Head of Old River Operable Barrier would require in-water pile driving. The installment of the cofferdam would require approximately 550 sheet piles to be set with 1 concurrent pile driver at the site. Approximately 15 piles, a maximum of 50 feet long and to a depth of 13.5 to 15 feet, will be set per day with 700 strikes per pile over an estimated 40 day period. Installation of steel sheet piles and/or king piles would require both impact and vibratory pile driving, depending on geotechnical conditions at the sites. Sheet piles would be installed in two phases starting with a vibratory hammer and then switching to impact hammer if refusal were encountered before target depths. The installment of the foundation for the operable barrier will require 100 14-inch steel pipe or H-piles to be set with 1 concurrent pile driver on site. Approximately 15 piles, a maximum of 50 feet long and to a depth of 13.5 to 15 feet, will be set per day with 1,050 strikes per pile over an estimated 7 day period. Foundation pile driving may be done in the dry or in the wet. If done in the dry, conventional construction methods would be used within the cofferdam. If done in the wet, a barge-mounted rig positioned outside of the cofferdam or a deckmounted pile driving rig located on decking over the top of the cofferdam would be required. If CIDH is chosen for the foundation, impact pile driving will not be required.

The cofferdam construction method would enable the gates to be constructed in two phases and would allow work within the cofferdam to continue through the winter. The first phase would involve the placement of a cofferdam in half of the channel and then dewatering the area so the bottom of the channel could be used as a construction site. The gates would be constructed within this area and on the adjacent levee. The cofferdam would remain in the water until the completion of half of the gate. It would then either be removed or cut off at the required invert depth and another cofferdam would be installed in the other half of the channel. In the second phase, the gate would be constructed using the same methods, with the cofferdam either removed or cut off, and incorporated into the final gate layout. Cofferdam construction would begin in August and last approximately 35 days. Construction activities within the cofferdam area would last until approximately early

November or could occur throughout the winter, depending upon weather and river flow conditions. The south Delta temporary barriers at this site would continue to be installed and removed as they are currently until the permanent gates are fully operable.

The in-the-wet method would involve working within the natural channel as it flows. No cofferdam or dewatering of the construction site would occur. Each gate would be constructed within the confines of the existing channel, and there would be no levee relocation. The channel invert would be excavated to grade using a sealed clamshell excavator working off the levee or from a barge. H-piles or other suitable deep foundation would be placed in the channel. Gravel and tremie concrete would be placed for the foundation within the confines of the H-piles. Reinforced concrete structures would then either be floated in or cast in place using prefabricated forms to be placed on top of the gravel, tremie concrete, and H-piles. Divers would complete the final connections between the concrete structures and the piles.

Dredging for the gate would occur up to 150 feet upstream and 350 feet downstream from the site is necessary to clear the area for construction and placement of the fish control gate. In total, up to 1,500 cubic yards of material would be dredged. Dredging would occur between August 1 and November 30, lasting approximately 15 days.

The boat lock for the Head of Old River Barrier would be constructed using sheetpiles and include two bottom-hinged gates on each end, measuring 20 feet wide and 10 feet high. Each gate would weigh approximately 8 tons and would be opened and closed using an air-inflated bladder. The invert of the lock would be at elevation –8.0 feet msl, and the top of the lock wall would be at elevation 15 feet. The boat lock would transport boats with the use of the bottom-hinged gates and a valve system for equalizing water levels, and would function by filling and emptying the lock chamber with a 36-inch valve.

A temporary work area of up to 15 acres would be required in the vicinity of the barrier for such uses as storage of materials, fabrication of concrete forms or gate panels, stockpiles, office trailers, shops, and construction equipment maintenance.

3.1.4 Forebays

3.1.4.1 Intermediate Forebay

3.1.4.1.1 Design

The IF will store water between the proposed intake and conveyance facilities and the main tunnel conveyance segment on Glannvale Tract. The IF would serve mainly as a pass-through facility providing an atmospheric break between Tunnels 1 and 2. Its capacity would be 750 acre feet (af).) It will include an emergency spillway and emergency inundation area to prevent the forebay from overtopping. This spillway will divert water during high flow periods to an approximately 131-acre emergency inundation area adjacent to and surrounding the intermediate forebay. From the intermediate forebay, water will be conveyed by a gravity bypass system through an outlet control structure into a dual-bore 40-foot-diameter tunnel for about 30 miles to an expanded CCF. This proposed water diversion configuration will enhance water supply operational flexibility, using forebay storage capacity to regulate flows from the proposed intakes to south Delta pumping plants.

3.1.4.1.2 Construction

The IF and the emergency inundation area would have a combined surface footprint of approximately 648 acres. Approximately 4.4 million cubic yards (cy) of earth would be excavated or borrowed from portions of the intermediate forebay. Dewatering would be required for excavation operations and is expected to be continuous throughout construction of the IF. Much of the excavated material is expected to be high in organics and unsuitable for use in embankment construction. Some of the excavated material below the peat layers may be suitable for use in constructing the embankments. To the extent possible, spoils to be used for the embankments would be stored onsite.

The planned embankment crest elevation for the IF would be +32.2 feet. The new embankments would be constructed by excavating the embankment foundations down to suitable material and then installing the slurry cutoff wall. After the cutoff wall is completed, the embankments will be constructed of compacted fill to the desired height. The IF would be developed by constructing a ring dike to surround the forebay. With the exception of the inlets and the outlet, the ring dike would be constructed of engineered fill. A slurry cutoff trench would be included beneath the embankment to protect the foundation of the embankment from underseepage and piping. A drain would be constructed at the toe of the outer embankment slope to limit saturated conditions at the ground surface.

The bottom elevation of the IF is proposed to be +0.0 ft except locally at the inlet and outlet connections. The incoming tunnels would transition to vertical shafts that terminate in the inlet structure, which would incorporate bulkhead gates. Flow would then pass through a transition structure that would include roller gates to reduce incoming velocities. At the south end of the IF, the outlet structure would consist of a concrete structure with a gated overflow weir at elevation +10.0 feet. Flows over the gated weir would discharge to a transition structure directing flow to the vertical outlet shafts. The inlet and outlet structures would be above grade with footprints of approximately 500 feet by 360 feet. The majority of the structures would be below ground.

Temporary parking areas during construction would be within the 1 to 5 acre construction staging area for each transition structure. Parking during operation may be available on forebay maintenance roads adjacent to and around three sides of the facilities, approximately 24 feet wide by 400 feet long.

3.1.4.2 Clifton Court Forebay

3.1.4.2.1 Design

The CCF would be expanded by approximately 590 acres to the southeast of the existing forebay. In addition, two combined 4,500 cfs pumping plants would be constructed and operated to sustain water levels in the CCF required for optimal pump operations at both Banks and Jones Pumping Plants when the gravity bypass is not utilized. The pumping plant facilities would include water treatment facilities, storage detention tanks, and electrical buildings.

3.1.4.2.2 Construction

The CCF would be dredged for expansion. A new embankment would be constructed around the perimeter of the forebay, as well as an embankment dividing the forebay into a northern cell and a southern cell. Tunnel 2 (from the proposed intakes) would enter the new pumping plant facility at the northeastern end of the CCF, immediately south of Victoria Island and flows would be pumped into the northern cell of the forebay. The northern cell of the CCF would provide storage between approximately 4,300 to 10,200 af. The southern cell of the forebay would continue to provide functionality for the existing through-Delta conveyance system and would provide storage of approximately 14,000 af.

The northern and southern forebay cells would be developed by constructing an embankment within the existing CCF embankment and by constructing a divider embankment through the middle of the existing CCF. Excavation at the toe of the existing embankment and levees may require the use of tied-back sheet piles, dewatering, and other geotechnical precautions to prevent failures of existing embankments and levees.

New embankments would be constructed by excavating the embankment down to suitable material, dewatering, and installing the slurry cutoff wall. Approximately 9.3 million cy of fill would be required for the modified CCF embankments, which includes the divider embankment separating the northern and southern cells, approach canal embankments, spillway pad, and siphon outlet pad. The required embankment material would be borrowed from within the limits of the respective forebays to the extent feasible, or from borrow sites.

A temporary cofferdam will be required within Clifton Court Forebay followed by dewatering of the construction area to allow filling of the area surrounding the pumping plant shafts to El. 25. Filter material and riprap will be placed over exposed soil on water side of embankments. These activities will be similar to those described above for the Intakes.

Limited soils information and subsurface data show that soils in the vicinity of North Clifton Court Forebay and South Clifton Court Forebay consist predominantly of silty and sandy clays, fine sands, and areas overlain by 2 to 10 feet of tidal peat and mud. This depth is simplified to an assumed 6 feet of peat for this stage of the forebay engineering.

If dredging is required prior to placement of sheet piles for embankment construction along shoreline and across Clifton Court Forebay, dredging will using a cutter head dredge, a dragline type dredge, or other acceptable dredging technique. Silt curtains or other means of limiting turbidity in the existing forebay are used as required.

Considering subgrade of the embankments and associated conveyance structures is on the order of 5 to 17 feet below sea level, pile installation is challenging. Drilled piers, pipe piles or displacement piles are employed as the primary foundation system under structures as required to resist uplift.

- Phase 1 will include sheet piles and cofferdam on southwest side of Clifton Court Forebay to facilitate construction of new channel and new embankments.
- Phase 2 will include sheet piles on southeast side of Clifton Court Forebay to facilitate construction of new embankments.
- Phase 3 will include sheet piles on south side of Clifton Court Forebay between sheet piles from Phases 1 and 2 to facilitate construction of new embankments. These sheet piles will be removed.
- Phase 5 will include sheet piles for the north half of the west outlet siphon structure.

- Phase 6 will include sheet piles on the east side embankment to support the new spillway and integration of the new embankment across Clifton Court Forebay.
- Phase 7 will include sheet piles on west side embankment on the north side embankment to support integration of the new embankment across Clifton Court Forebay – this may not require sheet piles.
- Phase 8 will include sheet piles on north side embankment on the north side embankment to support integration of the new embankment across Clifton Court Forebay – this may not require sheet piles.

Equipment for dewatering within the cofferdams and excavating down to foundation depth includes scrapers, excavators, bulldozers, off-road and on-road trucks as deemed appropriate. Place tremie slab, if necessary. Construct embankment scrapers, excavators, bulldozers, off-road and on-road trucks, compaction equipment, rollers, motor graders, and water trucks or water pulls to place material in lifts until finish heights are reached. Sheet piles will be trimed or removed and riprap will be placed on the slopes on the water side of the embankments.

For the embankment across Clifton Court Forebay existing soil will be dredged to an average depth of 6 feet to finish invert elevation. Dredging work will be conducted with a cutter head dredge, a dragline type dredge, or other acceptable dredging technique. Silt curtains or other means of limiting turbidity in the existing forebay are used as required. Sheet piles will be used for partitioning the forebay and dewatering North Clifton Court Forebay.

The area designated for the northern cell would be dredged to provide a bottom elevation -5.0 ft. except locally at the inlet and outlet connections. The portion of southern cell that lies within the extent of the existing CCF would be dredged to an elevation of approximately -10.0 ft., which would be the bottom elevation of the southern cell. Together, approximately 8 million cy of dredged material is expected to be removed from the northern and southern forebay cells. Where feasible, dredged material will be stored on higher elevation land that is set back from surface water bodies a minimum of 150 feet. Upland disposal will help ensure that the material will not be in direct contact with surface water prior to its draining, characterization, and potential treatment

Each pumping plant would have a design pumping capacity of 4,500 cfs and would include 4 large pumps (1,125 cfs capacity) and 2 smaller pumps (563 cfs capacity). The pumps would be vertical column discharge pumps, and one large pump at each plant would be a spare. Each pumping plant would be housed within a building and would have an associated electrical building. The pumping plant buildings would be circular structures with a diameter of 182 feet and each would be equipped with a bridge crane that would rotate around the building and allow for access to the main floor for pump removal and installation. The total site for the pumping plants, electrical buildings, substation, spillway, access roads, and construction staging areas is approximately 95 acres. The main floor of the pumping plants and appurtenant permanent facilities would be constructed at a minimum elevation of 25 feet to provide flood protection. The bottom of the pump shafts would be at an elevation of approximately -163 feet, though a concrete base slab, shaft lining, and diaphragm wall would be constructed to deeper levels (to an elevation of -275 feet). A control room within an electrical building at the pumping facility site would be responsible for controlling and monitoring the communication between the intake structures, pumping plants, and the Delta Field Division Operations and Maintenance Center, DWR Headquarters, and the Joint Operations Center.

A 230 kV transmission line and associated 230kV-115kV substation used during construction would be repurposed and used to power the pumping plants at the CCF location during operations. The repurposed substation would provide power to a new substation that would convert power from 115kV to 13.8kV. This substation would then include 13.8 kV feeder lines to a proposed electrical building to distribute the power to the major loads including the main pumps, dewatering pumps, and 13.8kV to 480V transformers.

3.1.5 Connections to Banks and Jones Pumping Plants

Two culvert siphons would be constructed; one would connect the north cell of the expanded CCF to a new approach canal to the Banks and Jones Pumping Plants under the existing CCF outlet channel, and one would connect the new approach canal to the existing approach canal to Banks Pumping Plant under Byron Highway and the Southern Pacific Railroad. At this proposed siphon location, a segment of Byron Highway and the Southern Pacific Railroad would be temporarily rerouted to accommodate construction of the siphon (i.e., effects limited to those during the 9- to 14-year construction period). A radial gate control structure would be installed at the downstream end of this new approach canal to hydraulically isolate the existing SWP facilities from the northern cell.

The northern cell would also be connected to the Jones Pumping Plant by a new 4,000 ft. canal. A branch off of the new canal section will connect to the existing Jones Pumping Plant approach canal. A radial gate control structure would be installed at the downstream end of the new canal to hydraulically isolate the existing CVP facilities from the northern cell of the forebay. Construction may require short shut downs of the existing conveyance system to the Banks and Jones Pumping Plants, to add new control structures to the existing pumping plant approach canals and when new approach canals are connected to the existing canals.

The culvert siphons would be constructed as large multiple-box culvert structures using cofferdams, shoring, and open cut-and-cover construction methods with conventional cast-in-place concrete structures. Cofferdams would be used to construct the outlet siphon from the northern forebay cell, and shoring would be used to construct the siphon in a single phase under Byron Highway and the Southern Pacific Railroad, requiring temporary realignment of these features during construction. Siphon construction is projected to begin in year 8 and end in year 10.

3.1.6 Power Supply and Grid Connections

3.1.6.1 Design

Electric power would be required for intakes, pumping plants, operable barriers, boat locks, and gate control structures throughout the proposed conveyance alignment. Temporary power would also be required during construction of water conveyance facilities. New temporary power lines to power construction activities would likely be built prior to construction of permanent transmission lines to power conveyance facilities. These lines would extend existing power infrastructure (lines and substations) to construction areas, generally providing electrical capacity of 12 kV at work sites. Main shafts for the construction of deep tunnel segments would require the construction of 69 kV temporary power lines.

The method of delivering power to construct and operate the water conveyance facilities is assumed to be a "split" system that would connect to the existing grid in two different locations. The northern point of interconnection would be located north of Lambert Road and west of Highway 99. From here, a new transmission line would run west, along Lambert Road, where one segment would run south to the intermediate forebay on Glannvale Tract; and one segment would run north to connect to a substation where 69 kV lines would connect to the intakes. While this new transmission line could be 230 kV, 115 kV, or 69 kV depending on further study, a 230 kV line was assumed for the purposes of analysis. At the southern end of the conveyance alignment, the point of interconnection may be in one of two possible locations: southeast of Brentwood near Brentwood Boulevard or adjacent to the Jones pumping plant. While only one of these points of interconnection would be used, both are depicted in figures, and the effects of constructing transmission lines leading from both sites are combined and accounted for in the effects analysis. A 230 kV line would stretch from one of these locations to a tunnel shaft northwest of CCF, and would then continue north, following tunnel shaft locations, to Bouldin Island. Lower voltage lines would be used to power intermediate and reception shaft sites between the main drive shafts. Because the power required during operation of the water conveyance facilities would be much less than that required during construction, and because it would largely be limited to the pumping plants, the "split" system would enable all of the new power lines in the northern part of the alignment to be temporary. Similarly, the new lines between Bouldin Island and the new pumping plant facility at CCF would also be temporary, limited to the construction schedule for the relevant tunnel reaches and features associated with CCF. An existing 500kV line, which crosses the area proposed for expansion of the CCF, would be relocated to the southern end of the expanded forebay in order to avoid disruption of existing power facilities.

Temporary substations would be constructed at each intake, at the intermediate forebay, and at each of the launch shaft locations. To serve permanent pumping loads, a permanent substation would be constructed adjacent to the pumping plants at CCF, where electrical power would be transformed from 230 kV to appropriate voltages for the pumps and other facilities at the pumping plant site. For operation of the three intake facilities and intermediate forebay, it is assumed for the purposes of analysis that existing distribution lines would be used to power gate operations, lighting, and auxiliary equipment at these facilities. Use of the existing distribution system for the purposes of construction and operations may require upgrades to existing lines, including reconductoring. While it is anticipated that utility interconnection facilities would be completed in time to support most construction activities, for some activities that need to occur early in the construction sequence (e.g., constructing raised pads at shaft locations and excavating the shafts), onsite generation may be required on an interim basis. As soon as the connection to associated utility grid power was completed, electricity from the interim onsite generators would no longer be used.

3.1.6.2 Construction

New transmission lines would generally follow the conveyance alignments and would be constructed within or adjacent to the alignment ROW. Temporary lines would be constructed from existing facilities to each worksite where power is necessary for construction. Construction of all transmission lines would require three phases: site preparation, tower or pole construction, and line stringing. For 12 kV and 69 kV lines, cranes would be used during the line stringing phase. For stringing transmission lines between 230 kV towers, cranes and helicopters would be used.

Construction of 230 kV and 69 kV transmission lines would require a corridor width of 100 feet and, at each tower or pole, 100 feet on one side and 50 feet on the other side for construction laydown, trailers, and trucks. Construction would also require about 350 feet along the corridor (measured from the base of the tower or pole) at conductor pulling locations, which includes any turns greater than 15 degrees and/or every 2 miles of line.

For construction of 12 kV lines (when not sharing a 69 kV line), a corridor width of 25–40 feet is necessary, with 25 feet in each direction along the corridor at each pole. Construction would also require 200 feet along the corridor (measured from the base of the pole) and a 50-foot-wide area at conductor pulling locations, which includes any turns greater than 15° and/or every 2 miles of line. For a pole-mounted 12 kV/480 volt transformer, the work area is only that normally used by a utility to service the pole (typically about 20 by 30 feet adjacent to pole). For pad-mounted transformers, the work area is approximately 20 by 30 feet adjacent to the pad (for construction vehicle access).

3.1.7 Temporary Access and Work Areas for Intake, Canal, and Pipeline/Tunnel Construction

Work areas during construction may include areas for construction equipment and worker parking, field offices, a warehouse, maintenance shops, equipment and materials laydown and storage, RTM spoils areas, and stockpiles. Borrow and spoils areas may be temporary or permanent. Materials to be stockpiled may include:

- Strippings from various excavations for possible reuse in landscaping.
- RTM that is slated for reuse after treatment for embankment or fill construction. RTM areas may be temporary or permanent.
- Peat spoils for possible use on agricultural land, as safety berms on the landside of haul roads, or as toe berms on the landside of embankments (cannot be part of the structural section).
- Other materials being stockpiled on a temporary basis prior to hauling to permanent stockpile areas.

Other temporary work areas would include those associated with the construction of canals, control structures, forebays, intakes, levees, operable barriers, pipelines, pumping plants, safe haven zones, siphons, and tunnels. Areas would also be dedicated to temporary transmission lines.

Temporary and new access/haul roads and detour roads would be required during construction of all water conveyance facilities. All-weather roads (asphalt paved) would be required for year-round construction at all facilities, including concrete and steel structures, tunnel portals, tunnel shafts, pumping plants and intakes, and for access to delivery areas and permanent RTM spoil piles. Dry-weather roads (minimum 12 inch thick gravel or asphalt paved) could be used for construction activities restricted to the dry season. Dust abatement would be addressed in all construction areas at all times. Heavy construction equipment, such as diesel-powered dozers, excavators, rollers, dump trucks, fuel trucks, and water trucks would be used during excavation, grading, and construction of access/haul roads. Detour roads would be needed for all intakes and for traffic circulation around the work areas. Roadway detours would likely be needed around each intake's construction zone (including intake pumping plant construction area) to provide site security and safety.

Temporary barge unloading facilities would be constructed at locations adjacent to construction work areas along the conveyance alignments (e.g., intake structure and culvert siphon worksites) for the delivery of construction materials. These facilities would be sized to accommodate various deliveries (e.g., tunnel segments, batched concrete, major equipment). Temporary barge unloading facilities for would be built at the following locations: Snodgrass Slough, Potato Slough, San Joaquin River, Middle River, Connection Slough, Old River, and the West Canal. Access roads from these facilities to the construction work area would be necessary. It is assumed that barge activities would take place on levees using a ramp barge in conjunction with a crane/excavator barge or a crane or excavator positioned on or near the levee. The barge unloading facilities would be removed following construction.

As described in Section 3.1.1.2, temporary concrete batch plants would be required due to the large amount of concrete required for construction and the schedule demands of the proposed action. The area required for these plants would range from approximately 1 to 38 acres. Fuel stations would be constructed adjacent to concrete batch plants and would occupy approximately 1 acre. While it is anticipated that precast tunnel segments would be purchased and transported from existing plants, it is possible that one or more temporary plants would be constructed. If constructed, these would be located adjacent to concrete plants. It is likely that each precast segment plant would require approximately 10 acres for offices, concrete plant, materials storage, and casting facilities. Additional acreage for segment storage would be needed at the precast segment plant site, and could run several times the space required for the plant.

3.1.8 Geotechnical Exploration

DWR will perform a series of geotechnical investigations along both the selected water conveyance alignment and at locations proposed for facilities or material borrow areas. The work to be performed will constitute a subsurface investigation program to provide information required to support the design and construction of the water conveyance facilities. Geotechnical investigations will be conducted to identify surface and subsurface conditions necessary to complete design of the water conveyance facilities. DWR has developed a Draft Geotechnical Exploration Plan (Phase 2) for water conveyance alignment. The geotechnical investigation plan provides additional details regarding the rationale, investigation methods and locations, and criteria for obtaining subsurface soil information and laboratory test data (California Department of Water Resources 2014).

The proposed exploration is designed as a two-part program (Phases 2a and 2b) to collect geotechnical data. The two-part program will allow refinement of the second part of the program to respond to findings from the first part. The proposed subsurface exploration will focus on geotechnical considerations of the following aspects of water conveyance facility development: engineering considerations, construction-related considerations, permitting and regulatory requirements, and seismic characterization considerations. The data obtained during the geotechnical exploration will be used to support the development of an appropriate geologic model, to characterize ground conditions, and to reduce the geologic risks associated with construction of proposed facilities.

Representative samples of subsurface materials will be collected from selected locations along the water conveyance alignment and at proposed facility sites, and the collected samples will be tested to support design. The distance from Intake 2 (the northern extent of the water conveyance facility) to the CCF (the southern extent) is approximately 39 miles. The proposed subsurface exploration will consist of field tests and laboratory testing of soil samples. The field tests will consist of soil borings, cone penetration testing (CPT), geophysical testing, pressure meter testing, excavation of test pits, installation of piezometers and groundwater extraction wells, dissolved gas sampling, and aquifer tests. The field exploration program will be planned to evaluate soil characteristics and to collect samples for laboratory testing, which will include soil index properties, strength, compressibility, permeability, and specialty testing to support TBM selection and performance specification.

The proposed Phase 2a and 2b exploration on land will consist of approximately 1,500–1,550 exploration locations including drilling boreholes and performing CPTs as well as conducting approximately 60 shallow test pit excavations (typically 4 feet wide, 12 feet long, and 12 feet deep) in soils to evaluate bearing capacity, physical properties of the sediments, location of the groundwater table, and other typical geologic and geotechnical parameters. CPT consists of pushing a cone connected to a series of rods into the ground at a constant rate, allowing continuous measurements of resistance to penetration both at the cone tip and the sleeve behind the cone tip. The resulting information correlates to the nature and sequence of subsurface soil strata, groundwater conditions, and physical and mechanical properties of soils.

Temporary pumping wells and piezometers may be installed at intake, forebay, pump shaft, and tunnel shaft sites to investigate soil permeability and to allow sampling of dissolved gases in the groundwater. Small test pits will be excavated to obtain near-surface soil samples for laboratory analysis. Drilling will take place at sites that are readily accessible by truck or track-mounted drill rigs.

After each site is explored, the boring, CPTs, and/or piezometers will be backfilled with cement-bentonite grout in accordance with California regulations and industry standards (Water Well Standards, DWR 74-81 and 74-90). Test pits will be backfilled with the excavated material on the same day as they are excavated with the stockpiled topsoil placed at the surface and the area restored as closely as possible to its original condition.

Exploration activities may consist of auger and mud-rotary drilling with soil sampling using a standard penetration test (SPT) barrel (split spoon sampler) and Shelby tubes; cone penetrometer testing; temporary well installation; test pits; and electrical resistivity and other geophysical surveys. All exploration methods will require a drill rig and support vehicle for the drillers and vehicles for the geologists and environmental scientists. DWR will implement best management practices that include measures for air quality, noise, greenhouse gases, and water quality. Direct impacts to buildings, utilities, known irrigation and drainage ditches, and biologically sensitive areas will be avoided during geotechnical exploration activities. The various on-land exploration methods may last from a few hours to several days.

Approximately 90–100 overwater geotechnical borings and CPTs are proposed to be drilled in the Delta waterways using the drilling method outlined in the above paragraph. These include approximately 30 overwater geotechnical borings and CPTs in the Sacramento River to obtain geotechnical data for the proposed intake structures. Approximately 25–35 overwater borings and CPTs are planned at the major water undercrossings along the tunnel alignment. An additional

30–35 overwater geotechnical borings and CPTs are proposed for the barge unloading facilities and CCF modifications. The depths of borings and CPTs are planned to range between 100 and 200 feet below the mud line (i.e., river bottom).

DWR plans to conduct overwater drilling only during the period from August 1 to October 31 between the hours of sunrise and sunset. Duration of drilling at each location will vary depending on the number and depth of the holes, drill rate, and weather conditions, but activities are not expected to exceed 60 days at any one location. Overwater borings for the intake structures and river crossings for tunnels will be carried out by a drill ship and barge-mounted drill rigs.

3.1.8.1 Phase 2a Geotechnical Exploration

Phase 2a exploration will focus mainly on collecting data to support preliminary engineering. This includes overwater and land-based soil borings and CPTs. The overwater explorations are planned to collect subsurface information to support the design of intake structures and the major water crossings along the conveyance alignment. Land-based explorations are planned for the intake perimeter berms, SR 160, sedimentation basins, pumping plants, forebay embankments, tunnel construction and vent shafts, and other appurtenant facilities. Approximately 600 boring and CPT locations are proposed for the Phase 2a exploration.

For the proposed tunnels, Phase 2a would entail soil borings approximately every 2,000 feet along the tunnel alignment and CPTs approximately every 2,000 feet midway between the borings. Overwater boreholes and CPTs are planned in Potato Slough, San Joaquin River, Connection Slough, and CCF. All of the land-based boreholes along the tunnel alignments will be converted into piezometers. CPTs are also proposed to be co-located at every third borehole to enable calibration of the CPT data with the in-situ geology encountered in the boreholes.

For tunnel shaft sites and CCF pumping plant shaft sites, six soil borings and four CPTs will be advanced at each planned shaft location. Once drilling is completed at each shaft site, two of the boreholes will be converted into groundwater extraction wells and the other four boreholes will be converted into piezometers. Boreholes and CPTs are also proposed for the intake and pumping plant sites and SR 160. Approximately six of the boreholes at each of the proposed intakes would be converted into piezometers.

The approximate number of planned boreholes and CPTs for Phase 2a are below. Exploration locations and the type will be adjusted based on field conditions and future engineering changes.

Table 3-4. Planned Phase 2a Boreholes and Cone Penetration Tests by Location

Location	Phase 2a- Planned boreholes and CPTs (approximate)
Potato Slough	2-3
San Joaquin River	2-3
Connection Slough	1-2
CCF	30-35

3.1.8.2 Phase 2b Geotechnical Exploration

Phase 2b exploration is proposed to collect geotechnical data to support final design, permitting requirements, and planning for procurement and construction-related activities. In addition to soil borings and CPTs, test pits would be created as part of Phase 2b exploration. Additional explorations may also be carried out before construction to affirm the validity of the data collected during the design phase. The Phase 2b subsurface exploration will aim to collect geotechnical data from those site areas and facility locations that have been verified by preliminary engineering and other associated studies. Approximately 950 boring, CPT, and test pit locations are proposed for the Phase 2b exploration.

For the proposed tunnels, the Phase 2b exploration will consist of advancing soil borings near the Phase 2a CPT locations such that a borehole will have been located at approximately 1,000-foot intervals along the entire tunnel alignment. CPTs will be advanced midway between the boreholes. This configuration would provide for a land-based exploratory location (borehole or CPT) spacing of approximately 500 feet along the tunnel alignment, a spacing that generally conforms to typical design efforts for tunnels like those proposed. The exploration proposed for the construction and ventilation shaft sites in Phase 2a would be expanded to include the safe haven intervention sites in Phase 2b. Overwater boreholes and CPTs are planned in the Sacramento River, Snodgrass Slough, South Fork Mokelumne River, San Joaquin River, Potato Slough, Middle River, Connection Slough, Old River, North Victoria Canal, and CCF.

The approximate number of planned boreholes and CPTs for Phase 2b are below. Exploration locations and the type will be adjusted based on field conditions, data collected during Phase 2a, and future engineering changes.

Table 3-5. Planned Phase 2b Boreholes and Cone Penetration Tests by Location

Location	Phase 2b- Planned boreholes and CPTs (approximate)
Sacramento River	25-30
Snodgrass Slough	2-3
South Fork Mokelumne River	2-3
San Joquin River	10-12
Potato Slough	15-18
Middle River	1-2
Connection Slough	5-7
Old River	4-6
West Canal	6-8
CCF	2-5

3.1.8.3 Schedule for Geotechnical Explorations

The estimated duration to complete the proposed Phase 2a and 2b land-based explorations is about 24 months, assuming six land-based drill rigs operating concurrently for six days per week. The estimated duration to complete the Phase 2a and 2b overwater explorations is about 14 months, assuming two drill rigs operating concurrently for 6 days per week. However, to maintain the proposed action development schedule, it is likely that 10–15 land-based drill rigs would be used simultaneously for 12–18 months to complete the exploration. The exploration duration will vary depending on the availability of site access, drilling contractors and equipment, permitting conditions, and weather. The proposed explorations are planned to be performed during the first 3 years of implementation.

3.2 Operations Criteria of the New and Existing Facilities

This subsection would include an introduction that explains the relationship between operational criteria that will be defined by the 2008 and 2009 biological opinions and new operational criteria that are being proposed once the new facilities are constructed.

Implementation of the proposed action will include operations of both new and existing water conveyance facilities once the new north Delta facilities are completed and become operational, thereby enabling coordinated management of north and south Delta diversions. Operations included in this proposed action for south Delta export facilities would replace the south Delta operations currently implemented in compliance with the FWS (2008) and NMFS (2009) BiOps. The proposed action also includes a new criteria for spring outflow to specifically avoid unacceptable effects on longfin smelt and a new minimum flow criteria at Rio Vista from January through August. The North Delta Intakes and the permanent head of Old River barrier are new facilities and will be operated consistent with the new proposed operating criteria for each of these facilities. All other criteria included in the FWS (2008) and NMFS (2009) BiOps[1] and D-1641, including Fall X2, the E:I ratio, and operations of the Delta Cross Channel gates and the Suisun Marsh Salinity Control Gates will continue to be complied with as part of the continued operations of the CVP and SWP. As such, the proposed action includes modified or new operations criteria for the following facilities:

- North Delta intake facilities and associated bypass flow criteria
- South Delta intakes and export operations
- Permanent Head of Old River barrier and its operations

Proposed action also include new operations criteria specified below:

- Spring Delta outflow
- Rio Vista minimum flow standard in January through August

The proposed criteria are further described in the following subsections and in Table 3-1. The proposed action operations include a preference for south Delta pumping in July through September to provide limited freshwater flushing for maintaining general water quality conditions and reduced residence times to protect against water quality degradation in the south Delta.

3.2.1 Implementation

[1] 2009 NMFS BiOp RPA IV.2.1 San Joaquin River Inflow to Export Ratio is not part of the Proposed Action. In lieu of this criteria, a San Joaquin River flow dependent Old and Middle River Flow Requirement is proposed.

CM1 focuses on several components of CVP and SWP water operations in the Plan Area that compose a flow regime intended to contribute to achieving the biological goals and objectives. These components include operations of the south Delta export facilities, a new Head of Old River operable gate, new north Delta intake facilities, Delta Cross Channel gates, the Suisun Marsh Salinity Control Gates, and a new North Bay Aqueduct intake. Each of these individual operations is proposed to interact and complement each other to provide important biological and water supply functions. Additionally, climate change effects in the Delta and in connected upstream areas were considered in the development of CM1. Operations under CM1 represent a substantial change in Delta flows, and in some instances real-time operations will be applied to minimize adverse biological and water supply effects. Two key drivers of Delta operations, Fall X2 and spring outflow, which are controlled in part by many of the individual operational components described above, are designed to respond to developing science and information that would be amassed between the time of permit issuance and operations under CM1. The process for determining these specific operations is outlined in a decision tree as described below. Upon commencing operations, adaptive management of CM1 would be used to further adjust and fine tune operations to maximize benefits and minimize adverse effects on biological resources and water supply.

During the initial years of BDCP implementation, flow management will be performed consistent with the current BiOps, as amended under court order, and any other regulatory or legal constraints that may be imposed in the future. Implementation of flow management under CM1 will be initiated when the new north Delta intakes become operational, thereby enabling joint management of north and south Delta diversions. This is estimated to occur beginning in year 10. CM1 implementation is discussed in the following sections of the BDCP Public Draft.

- Section 3.4.1.4.1, *Proposed Water Facilities,* describes the primary proposed water facilities: north Delta intakes, an alternative North Bay Aqueduct intake, and a Head of Old River operable gate.
- Section 3.4.1.4.2, *Management Structure*, describes CM1 governance, particularly the monitoring, research, and adaptive management program and the interactions with related entities, especially those involved in real-time operations.
- Section 3.4.1.4.3, *Flow Constraints*, describes the seasonal flow constraints that have been used to estimate the biological effects of diversion operations. Operational flow constraints would be subject to real-time operations adjustments (Section 3.4.1.4.5), but would closely resemble the modeled constraints.
- Section 3.4.1.4.4, *Decision Trees*, describes the decision trees that would be used to set flow constraints with regard to two critical variables—spring outflow and fall outflow—and how they will be implemented.
- Section 3.4.1.4.5, *Real-Time Operational Decision-Making Process*, describes how operations will be managed to control the day-to-day or instantaneous operations of the diversions within the context of the flow constraints.
- Section 3.4.1.4.6, *Facility Maintenance Actions*, identifies actions needed for facility maintenance.

3.2.1.1 Proposed Water Facilities

Two new water control facilities will be constructed: three North Delta intakes with their associated conveyance and support facilities, and a new permanent Head of Old River operable gate. Each of these facilities are described above in Section 3.1.

3.2.1.1.1 North Delta Intakes

Three new north Delta intakes will be located along the Sacramento River. Each intake will have a capacity of up to 3,000 cfs and will be fitted with fish screens designed to minimize entrainment or impingement risk for all covered fish species. Diverted waters will be conveyed to a new regulating forebay, and then south to SWP/CVP canals, via a pipeline and tunnel system. Construction of the north Delta intakes will allow great flexibility in operation of both south and north Delta diversions, as well as operation of the Delta Cross Channel. Diversions at the north Delta intake would be greatest in wetter years and lowest in drier years, when south Delta diversions would provide the majority of the CVP and SWP south of Delta exports. This is a result of north Delta bypass flow requirements, which are described in more detail below. Actual Delta channel flows and diversions may be modified to respond to real-time operational needs such as those related to Old and Middle Rivers, Delta Cross Channel, or north Delta bypass flows. The north Delta intakes and conveyance system are described in detail in BDCP Public Draft Chapter 4, Section 4.2.1.1, *North Delta Diversions Construction and Operations*.

Constraints incorporated in the design and operation of the north Delta intakes include the following.

- The new north Delta diversion facilities will consist of three separate intake units with a total, combined intake capacity not exceeding 9,000 cfs (maximum of 3,000 cfs per unit; details in BDCP Public Draft Chapter 4, Section 4.2.1.1, *North Delta Diversions Construction and Operations*).
- Project conveyance is provided by a tunnel capacity sized to provide for gravity flow from an intermediate forebay to the south Delta pumping facilities (BDCP Public Draft Chapter 4, Section 4.2.1.2, *State Water Project Facilities Operations and Maintenance*).
- The facility will, during operational testing and as needed thereafter, demonstrate compliance with the then-current NOAA and CDFW fish screening design and operating criteria, which govern such things as approach and passing velocities and rates of impingement. In addition, the screens will be operated to achieve the following performance standard and will be deemed to be out of compliance with permit terms if the standard is exceeded: Maintain survival rates through the reach containing new north Delta intakes (0.25 mile upstream of the upstream-most intake to 0.25 mile downstream of the downstream-most intake) to 95% or more of the existing survival rate in this reach. The reduction in survival of up to 5% below the existing survival rate will be cumulative across all screens and will be measured on an average monthly basis.
- The facility will precede full operations with a phased test period during which DWR, in close collaboration with NMFS and CDFW, will develop detailed plans for appropriate tests and use those tests to evaluate facility performance across a range of pumping rates and flow conditions. DWR will also implement operational constraints that minimize adverse impacts on covered fish species within that operational range, and demonstrate that biological performance standards are being achieved (BDCP Public Draft Chapter 3, Section 3.4.1.5, *Adaptive Management and Monitoring*). This phased testing period will include biological studies and monitoring efforts to enable the measurement of survival rates (both within the screening reach and downstream to

Chipps Island), and other relevant biological parameters which may be affected by the operation of the new intakes.

- Operations will be managed at all times to avoid increasing the magnitude, frequency, or duration of flow reversals in Georgiana Slough above pre-NDD operations levels.
- The fish and wildlife agencies (USFWS, NMFS, and CDFW) retain final authority over the operational criteria and constraints (i.e., which pumping stations are operated and at what pumping rate) during testing. The fish and wildlife agencies are also responsible for evaluating and determining whether the diversion structures are achieving performance standards for covered fishes over the course of operations. Consistent with the experimental design, the fish and wildlife agencies will also determine when the testing period should end and full operations consistent with developed operating criteria can commence. In making this determination, fish and wildlife agencies expect and will consider that, depending on hydrologies, it may be difficult to test for a full range of conditions prior to commencing full operations. Therefore, tests of the facility to ensure biological performance standards are met are expected to continue intermittently after full operations begin, to enable testing to be completed for different pumping levels during infrequently occurring hydrologic conditions.
- A work group will be formed by the AMT to design and implement a research program to address the key uncertainties identified in Table 3.4.1-5 (BDCP Public Draft Chapter 3).
- Based on the results of the studies described above initial operating criteria will be established, including conditions under which pumping levels will be adjusted within the bypass flow criteria to minimize effects on migrating covered fish and to achieve water supply goals. This will include the use of real-time monitoring information on fish movements upstream of and in the Delta in response to hydrologic conditions and other behavioral cues.
- Once full operation begins, the real-time operations program will be used to ensure that adjustments in pumping are made when needed for fish protection or as appropriate for water supply.
- Initial post-pulse operations during juvenile migration (Dec-Jun):
    - While fish are migrating only Level 1 pumping is allowed.
    - When fish are not migrating Level 2 or 3 is allowed according to the criteria in Table 3.4.1-2 (BDCP Public Draft Chapter 3).
    - If during Level 2 or 3 pumping fish are detected migrating towards the north Delta diversion, pumping will ramp down to Level 1.
    - The work group formed by the AMT will determine how to develop the triggers that will determine real-time operations related to covered fish migration past the north Delta diversions. This group will also determine the criteria for how pumping changes between levels (i.e., between Level 1, 2, and 3) in changes in covered fish migrations (i.e., presence or absence of a certain density or number of fish).
    - Bypass flow criteria can follow Table 3.4.1-2 (BDCP Public Draft Chapter 3) alone if other measures developed through research can minimize effects on migrating covered fish past the north Delta diversions (e.g., floating surface structures diverting fish to the opposite side of the Sacramento River from the diversions).

- Over time, the Adaptive Management Program will review the efficacy of the North Delta bypass criteria, in conjunction with its performance review on all the conservation measures, to determine what adjustments, if any, are needed to make sufficient progress towards the biological goals and objectives for salmon survival.
- DWR will contract with the Delta Science Program to host an independent review of the engineering design and approach to meeting biological criteria, including lessons learned from other large screening programs.

3.2.1.1.2 Head of Old River Operable Gate

A new permanent, operable gate at the head of Old River (at the divergence from the San Joaquin River) would be constructed and operated to protect outmigrating San Joaquin River salmonids in the spring and to provide water quality improvements in the San Joaquin River in the fall. The temporary agricultural barriers (on Middle River and Old River near Tracy and Grant Line Canal) will continue to be installed. Operation of the Head of Old River gate can vary from completely open (laying flat on the channel bed) to completely closed (erect in the channel, prohibiting all flow from the San Joaquin River to Old River), with the potential for operations in between that would allow partial flow. The actual operation of the gate would be determined by real-time operations based on actual flows and/or fish presence.

Table 3-6. New and Existing Water Operations Flow Criteria and Relationship to Assumptions in CALSIM Modeling

Parameter	Criteria	Summary of CALSIM Modeling Assumptionsa
	New Criteria Included in the Proposed Action	
North Delta bypass flows	• Initial Pulse Protection: ○ Low-level pumping of up to 6% of total Sacramento River flow such that bypass flow never falls below 5,000 cfs. No more than 300 cfs can be diverted at any one intake. ○ If the initial pulse begins and ends before Dec 1, post-pulse criteria for May go into effect after the pulse until Dec 1. On Dec 1, the Level 1 rules defined below apply until a second pulse, as defined above, occurs. The second pulse will have the same protective operation as the first pulse. • Post-pulse Criteria (specifies bypass flow required to remain downstream of the North Delta intakes): ○ October, November: bypass flows of 7,000 cfs before diverting at the North Delta intakes. ○ July, August, September: bypass flows of 5,000 cfs before diverting at the North Delta intakes. ○ December through June: post-pulse bypass flow operations will not exceed Level 1 pumping unless specific criteria have been met to increase to Level 2 or Level 3 as defined in the Section 3.4.2. If those	• Initial Pulse Protection: ○ Low-level pumping of up to 6% of total Sacramento River flow such that bypass flow never falls below 5,000 cfs. No more than 300 cfs can be diverted at any one intake. ○ If the initial pulse begins and ends before Dec 1, criteria for the appropriate month (Oct-Nov) go into effect after the pulse until Dec 1. On Dec 1, the Level 1 rules defined below apply until a second pulse, as defined above, occurs. The second pulse will

[2]Consistent with Table 3.4.1-2 in the BDCP Public draft

	criteria are met, operations can proceed as defined in Table 3-2[2]. The specific criteria for transitioning between and among pulse protection, Level 1, Level 2, and/or Level 3 operations, will be developed and based on real-time fish monitoring and hydrologic/behavioral cues upstream of and in the Delta. *<include specific transitioning criteria when available>*. During operations, adjustments are expected to be made to improve water supply and/or migratory conditions for fish by making real-time adjustments to the pumping levels at the north Delta diversions. These adjustments would be managed under RTOs.	have the same protective operation as the first pulse.
South Delta operations	• October, November: No south Delta exports during the D-1641 San Joaquin River 2-week pulse, no OMR flow restriction during 2 weeks prior to pulse, and a monthly average of −5,000 cfs in November after pulse. • December: OMR flows will not be more negative than an average of −5,000 cfs when the Sacramento River at Wilkins Slough pulse triggers, and no more negative than an average of −2,000 cfs when the delta smelt action 1 triggers. No OMR flow restriction prior to the Sacramento River pulse, or delta smelt action 1 triggers. • January, February[3]: OMR flows will not be more negative than a monthly average of 0 cfs during wet years, −3,500 cfs during above-normal years, or −4,000 cfs during below-normal to critical years, except −5,000 in January of dry and critical years. • March[4]: OMR flows will not be more negative than a monthly average of 0 cfs during wet or above- normal years or −3,500 cfs during below-normal and dry year and -3,000 cfs during critical years. • April, May: Allowable OMR flows depend on gauged flow measured at Vernalis, and will be determined by a linear relationship. If Vernalis flow is below 5,000 cfs, OMR flows will not be more negative than -2000 cfs. If Vernalis is 6,000 cfs, OMR flows will not be less than +1000 cfs. If Vernalis is 10,000 cfs, OMR flows will be at least +2,000 cfs. If Vernalis is 15,000 cfs, OMR flows will be at least +3,000 cfs. If Vernalis is at or exceeds 30,000 cfs, OMR flows will be at least 6,000 cfs. • June: Similar to April, allowable flows depend on gaged flow measured at Vernalis. However, if Vernalis is less than 3,500 cfs, OMR flows will not be more negative than −3,500	• October, November: Assumed no south Delta exports during the D-1641 San Joaquin River 2-week pulse, no OMR restriction during 2 weeks prior to pulse, and −5,000 cfs in November after pulse. • December: −5,000 cfs only when the Sacramento River pulse based on the Wilkins Slough flow (same as the pulse for the north Delta diversion) occurs, if no OMR requirement was applied. If the USFWS (2008) BiOp Action 1 is triggered, after which −2,000 cfs requirement is assumed. • April, May: OMR requirement for the Vernalis flows falling between5000 cfs and 30000 cfs were determined by linear interpolation. For example, when Vernalis flow is between 5,000 cfs and 6,000 cfs, OMR requirement is determined by linearly interpolating between −2,000 cfs and +1,000 cfs. • January–March and July–

[2]Consistent with Table 3.4.1-2 in the BDCP Public draft

[3] Sacramento River 40-30-30 index based water year types. For January and February, anticipated water year type based on the forecasted hydrology will be used. CALSIM II modeling uses previous water year type for October through January, and the current water year type from February onwards.

[4] [4] Sacramento River 40-30-30 index based water year types. For March, anticipated water year type based on the forecasted hydrology will be used. CALSIM II modeling uses previous water year type for October through January, and the current water year type from February onwards.

<table>
<tr>
<td></td>
<td>cfs. If Vernalis exceeds 3,500 cfs and up to 10,000 cfs, OMR flows will be at least 0 cfs. If Vernalis exceeds 10,000 cfs and up to 15,000 cfs, OMR flows will be at least +1,000 cfs. If Vernalis exceeds 15,000 cfs, OMR flows will be at least +2,000 cfs.
• July, August, September: No OMR flow constraints.</td>
<td>September: Same as the criteria</td>
</tr>
<tr>
<td>Head of Old River gate operations</td>
<td>• October 1–November 30th: RTO management in order to protect the D-1641 pulse flow designed to attract upstream migrating adult Fall-Run Chinook Salmon. HORB will be closed approximately 50% during the time immediately before and after the SJR pulse and that it will be fully closed during the pulse unless new information suggests alternative operations are better for fish.
• January: When salmon fry are migrating, (determined based on real time monitoring), initial operating criterion will be to close the gate subject to RTO for purposes of water quality, stage, and flood control considerations.
• February–June 15th: Initial operating criterion will be to close the gate subject to RTO for purposes of water quality, stage, and flood control considerations. The agencies will actively explore the implementation of reliable juvenile salmonid tracking technology which may enable shifting to a more flexible real time operating criterion based on the presence/absence of covered fishes.
• June 16 to September 30, December: Operable gates will be open.</td>
<td>• Assumed 50% open from January 1 to June 15, and during days in October prior to the D-1641 San Joaquin River pulse. Closed during the pulse. 100% open in the remaining months.</td>
</tr>
<tr>
<td>Spring outflow</td>
<td>March, April, May: Initial operations will provide additional flow to maintain the March–May average delta outflow that would occur under the 2008 USFWS Smelt BiOp and 2009 NMFS Salmon BiOp biological opinions at the time North Delta Diversion would become operational. March – May average delta outflow targets representative of the outflows under the current BiOps at the time the North Delta Diversion will be operational are tabulated for 10% exceedance intervals. March–May Average Outflow Criteria
<table>
<tr><th>Exceedance</th><th>Outflow criterion (cfs)*</th></tr>
<tr><td>10%</td><td>44,500</td></tr>
<tr><td>20%</td><td>44,500</td></tr>
<tr><td>30%</td><td>35,000</td></tr>
<tr><td>40%</td><td>27,900</td></tr>
<tr><td>50%</td><td>20,700</td></tr>
<tr><td>60%</td><td>16,800</td></tr>
<tr><td>70%</td><td>13,500</td></tr>
<tr><td>80%</td><td>11,500</td></tr>
<tr><td>90%</td><td>9,100</td></tr>
</table>
* Values based on Mar – May average Delta Outflow modeled under No Action Alternative using January 27th, 2015 version of CALSIM II considering the climate change and sea level rise effects projected at Early Long Term (around year 2025), and not including San Joaquin River Restoration Flows. The detailed modeling assumptions for this No Action Alternative are described in</td>
<td>• Since 2009 NMFS BiOp San Joaquin River i-e ratio constraint is the primary driver for the Apr-May Delta outflow under the No Action Alternative, this criteria was used to constrain Apr-May total Delta exports under the Proposed Action to meet Mar-May Delta outflow targets.</td>
</tr>
</table>

	Section xxxx. **For conditions drier than 90% exceedance outflow targets will be based on the SWRCB's D-1641requirements, and no additional outflow will be provided.* **Outflow can be achieved through export reductions, Oroville releases, and/or water acquired for environmental benefits.*	•
Rio Vista minimum flow standard	• January through August: flows will exceed 3,000 cfs • September through December: flows per D-1641	• Same as CM1 criteria
Key Existing Criteria Included in Modeling		
Fall outflow	• No change. September, October, November implement the USFWS (2008) BiOp Fall X2 requirements.	• September, October, November implement the USFWS (2008) BiOp Fall X2 requirements..
Winter and summer outflow	• No change. Flow constraints established under D-1641 will be followed if not superseded by criteria listed above.	• SWRCB D-1641 delta outflow and February – June X2 criteria.
Delta Cross Channel Gates	• No change. • Operations as required by NMFS (2009) BiOp Action 4.1 and D-1641	• Delta Cross Channel gates are closed for a certain number of days during October 1 through December 14 based on the Wilkins Slough flow, and the gates may be opened if the D-1641 Rock Slough salinity standard is violated because of the gate closure. Delta Cross Channel gates are assumed to be closed during December 15 through January 31. February 1 through June 15, Delta Cross Channel gates are operated based on D-1641 requirements.
Suisun Marsh Salinity Control Gates	• No change. Gates would continue to be closed up to 20 days per year from October through May.	For the DSM2 modeling, used generalized seasonal and tidal operations for the gates. • Seasonal operation: The radial gates are operational from Oct to Feb if Martinez EC is higher than 20000, and for remaining months they remain open. • Tidal operations when gates are operational: Gates close when: downstream channel flow is < 0.1 (onset of flood tide); Gates open when: upstream to downstream stage difference is greater than 0.3 ft (onset of ebb tide)

Export to inflow ratio	• No change. Operation criteria are the same as defined under D-1641. • The D-1641 export/inflow (E/I) ratio calculation was designed to protect fish from south Delta entrainment. For the proposed action, Reclamation and DWR propose that the NDD does not affect either Delta inflows or exports as they relate to the E/I ratio calculation. In other words, Sacramento River inflow is defined as flows downstream of the NDD and only south Delta exports are included for the export component of the criteria.	• Combined export rate is defined as the diversion rate of the Banks Pumping Plant and Jones Pumping Plant from the south Delta channels. • Delta inflow is defined as the sum of the Sacramento River flow downstream of the proposed north Delta diversion intakes, Yolo Bypass flow, Mokelumne River flow, Cosumnes River flow, Calaveras River flow, San Joaquin River flow at Vernalis, and other miscellaneous in-Delta flows.

[a] See Table 3-4 for Proposed Action CALSIM II Modeling Assumptions
Table C.A-1, CALSIM II Modeling Assumptions for Existing Conditions (EBC1), No Action Alternative (EBC2) and BDCP Operational Scenarios, in Draft BDCP Appendix 5.C, Attachment 5.C.A.

3.2.1.2 Application of Flow Criteria

Flow criteria are applied seasonally (month by month) and according to the following five water-year types. Under the observed hydrologic conditions over the 82-year period (1922–2003), the number of years of each water-year type is included below. The water-year type classification for the majority of the criteria mentioned here, unless noted differently, is based on the Sacramento Valley 40-30-30 Water Year Index defined under D-1641.

- Wet water year: the wettest 26 years of the 82-year hydrologic data record, or 32% of years.
- Above-normal water year: 12 years of 82, or 15%.
- Below-normal water year: 14 years of 82, or 17%.
- Dry water year: 18 years of 82, or 22%.
- Critical water year: 12 years of 82, or 15%.

Water operations under the proposed action are then constrained as shown in Table 3-1.

3.2.2 Proposed Flow Criteria for North Delta SWP and CVP Export Facilities

This subsection would describe the proposed change in point of diversion for the North Delta and associated operational/flow criteria.

Diversions at the north Delta intake would be greatest in wetter years and lowest in drier years, when south Delta diversions would provide the majority of the CVP and SWP south of Delta exports. This is a result of north Delta bypass flow requirements, described below. Additionally, the proposed action operations include a preference for south Delta pumping in July through September to avoid water quality degradation in the south Delta.

The objectives of the north Delta diversion bypass flow criteria include regulation of flows to (1) maintain fish screen sweeping velocities; (2) reduce upstream transport from downstream channels in the channels downstream of the intakes; (3) support salmonid and pelagic fish transport and migration to regions of suitable habitat; (4) reduce losses to predation downstream of the diversions; and (5) maintain or improve rearing habitat conditions in the north Delta.

To ensure that these objectives are met, diversions must be restricted at certain times of the year (mostly from December through June) when juvenile covered fish species are present. This is achieved by restricting the diversion to low level pumping when the juvenile fish begin their outmigration, which generally coincides with seasonal high flows triggered by fall/winter rains (called *pulse flows*); followed by providing adequate flows during the remainder of the outmigration (called *post-pulse operations*). \are intended to. Additional but less restrictive requirements apply for the late spring to late fall period. The north Delta diversion bypass flow criteria comprise two components that are applied to the Sacramento River: (1) initial pulse protection; and (2) three levels of post-pulse operations. These components are summarized below. A third component termed as "low-level pumping" allows diversion of 6% of Sacramento River flow measured upstream of the intakes up to 900 cfs (300 cfs per intake) year-round as long as Sacramento River downstream of the intakes is at least 5000 cfs.

The initial pulse of juvenile fish migration is a natural occurrence caused by the first substantial runoff event of the season. This can occur as early as October or as late as February, but usually happens in December or January. During the initial pulse, river flows will be diminished only by low-level pumping to the extent allowed under the rules described below. If the initial pulse occurs prior to Dec 1, then an assessment will be made to decide when a second pulse is necessary to be protected similar to the first pulse. A flow condition will be categorized as an initial pulse based on real-time monitoring of flow at Wilkins Slough and juvenile fish movement. The definition of the initial pulse for the purposes of modeling is provided below.

At the end of the initial pulse phase, post-pulse operations will apply, with potential adjustments made based on real-time operations as described in Table 3-6. The conditions that trigger the transition from the initial pulse protection to post-pulse operations are described below, along with bypass operating rules for the post-pulse phase, which provide maximum allowable levels of diversion for a given Sacramento River inflow measured upstream of the intakes. Additionally, as described in Table 3-6, there will be biologically-based triggers to allow for transitioning between and among the different diversion levels shown in Table 3-7.

In July through September, the bypass rules are less restrictive, allowing for a greater proportion of the Sacramento River to be diverted, as described in Table 3-6. In October through November the bypass amount is increased from 5000 cfs to 7000 cfs, allowing a smaller proportion of the Sacramento River to be diverted.

Table 3-7. Flow Criteria for North Delta Diversion Bypass Flows

Low-Level Pumping (December–June)
Diversions up to 6% of the total Sacramento river flow above the north delta intakes are allowed as long as the bypass flows never fall below 5000 cfs with a maximum of 300 cfs at any one intake.

Initial Pulse Protection

Low-level pumping will be maintained through the initial pulse period. For the purpose of modeling, the initiation of the pulse is defined by the following criteria: (1) Wilkins Slough flow changing by more than 45% within a 5-day period and (2) Wilkins Slough flow on the fifth day greater than 12,000 cfs. Low-level pumping continues until either (1) Wilkins Slough returns to pre-pulse flows (flow on first day of the pulse), or (2) Wilkins Slough flows decrease for 5 consecutive days, or (3) Wilkins Slough flows are greater than 20,000 cfs for 10 consecutive days. After the pulse period has ended, operations will return to the bypass flows identified below under Post-Pulse Operations. These parameters are for modeling purposes. Actual operations will be based on real-time monitoring of hydrologic conditions and fish movement.

If the initial pulse begins and ends before December 1, the Level 1 post pulse criteria May will go into effect after the pulse until December 1. On December 1, the post-pulse rules defined below for December through April, starting with Level 1 apply. If a second pulse, as defined above, occurs, the second pulse will have the same protective operation as the first pulse. These parameters are for modeling purposes. To be protective of present species, actual operations between pulses will be based on real-time monitoring of hydrologic conditions and fish movement.

Post-Pulse Operations

After initial pulse(s), go to Level I post-pulse bypass rules tabulated below until 15 total days of bypass flows above 20,000 cfs. Then go to the Level II post-pulse bypass rule until 30 total days of bypass flows above 20,000 cfs. Then go to the Level III post-pulse bypass rule.

Level I Post-Pulse Operations			Level II Post-Pulse Operations			Level III Post-Pulse Operations		
If Sacramento River at Freeport flow…			If Sacramento River at Freeport flow…			If Sacramento River at Freeport flow…		
Is over…	But not over…	The bypass is…	Is over…	But not over…	The bypass is…	Is over…	But not over…	The bypass is…
December–April								
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 80% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 60% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 50% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,600 cfs plus 60% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	13,400 cfs plus 50% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	12,000 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	No limit	18,400 cfs plus 30% of the amount over 20,000 cfs	20,000 cfs	No limit	15,900 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	No limit	13,000 cfs plus 0% of the amount over 20,000 cfs
May								
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs

5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 70% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 50% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 40% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,400 cfs plus 50% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	13,000 cfs plus 35% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	11,400 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	No limit	17,900 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	No limit	14,750 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	No limit	12,400 cfs plus 0% of the amount over 20,000 cfs
June								
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 60% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 40% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 30% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,200 cfs plus 40% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	12,600 cfs plus 20% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	10,800 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	No limit	17,400 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	No limit	13,600 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	No limit	11,800 cfs plus 0% of the amount over 20,000 cfs
July–September								
The bypass flow is 5,000 cfs			The bypass flow is 5,000 cfs			The bypass flow is 5,000 cfs		
October–November								
The bypass flow is 7,000 cfs			The bypass flow is 7,000 cfs			The bypass flow is 7,000 cfs		

3.2.3 Proposed New Flow Criteria for CVP and SWP South Delta Export Facilities

This subsection would describe the new flow criteria to be implemented in the South Delta.

The objectives of the new south Delta flow criteria are to minimize take at south Delta pumps by reducing incidence and magnitude of reverse flows during critical periods for fish species. The south Delta channel flow criteria are based on the parameters for Old and Middle River (OMR) flows and the San Joaquin River inflow , as summarized below, and Head of Old River Barrier operations (summarized in Section 3.2.4). Additionally, the proposed action operations include a preference for south Delta pumping in July through September to provide limited flushing to avoid water quality degradation in the south Delta.

3.2.3.1 OMR Flows

The OMR flow criteria chiefly serve to constrain the magnitude of reverse flows in the Old and Middle Rivers to limit fish entrainment and increase the likelihood that Delta Smelt can successfully reproduce in the San Joaquin River. The criteria are derived from fish protection triggers described in the USFWS (2008) and NMFS (2009) BiOps RPA Actions, and are described in Table 3-6. The proposed OMR flow criteria is used to constrain the south Delta exports, if the OMR flow requirements under current BiOps are not as constraining as the proposed criteria. These newly proposed OMR criteria (and associated Head of Old River Barrier operations in Section 3.4.4) are in response to expected changes under the Proposed Action, and only applicable after the proposed north Delta diversion becomes operational.

In April, May, and June, OMR minimum allowable values would be based upon the San Joaquin River inflow (Table 3-6). In October and November, OMR and south Delta export restrictions are based upon State Water Board D-1641 pulse trigger, as follows.[5]

- Two weeks before the State Water Board D-1641 pulse trigger: no OMR restrictions.
- During State Water Board D-1641 pulse trigger: no south Delta exports.
- Two weeks following State Water Board D-1641 pulse trigger: OMR operated to be no more negative than -5,000 cfs through November.

Additionally, new criteria based on the water year type in December through March would be implemented as described in detail in Table 3-6. The new criteria is generally more constraining under the wetter years compared to the requirements under the current BiOps.

3.2.4 Operations of the New Head of Old River Operable Barrier

Operations for the Head of Old River gate would be managed as follows.

- **October 1–November 30**: RTO management and HORB will be closed in order to protect the D-1641 pulse flow designed to attract upstream migrating adults.
- **January:** When salmon fry are migrating (determined based on real time monitoring), initial operating criterion will be to close the gate subject to RTO for purposes of water quality, stage, and flood control considerations.
- **February – – June 15**: The gate will be closed, but subject to RTO for purposes of water quality, stage, and flood control considerations. The agencies will actively explore the implementation of

[5] For the purposes of modeling, it was assumed that the D-1641 pulse in San Joaquin River occurs in the last 2 weeks of October.

reliable juvenile salmonid tracking technology which may enable shifting to a more flexible real time operating criterion based on the presence/absence of covered fishes.

- **June 16 to September 30, December:** Operable gates will be open.

3.2.5 Real-Time Operational Decision-Making Process

<NEED TO ADD IN PROCESS/MEMBERSHIP WHEN DECIDED>>

RTO Team decisions are expected to be needed during at least some part of the year at the Head of Old River gate and the north and south Delta diversion facilities. The RTO Team in making operational decisions that depart from the criteria used in the modeling will take into account upstream operational constraints, such as coldwater pool management, instream flow, and temperature requirements. The extent to which real time adjustments that may be made to each parameter related to these facilities shall be limited by the criteria and/or ranges set out in Table 3-1. That is, operational adjustments shall be consistent with the criteria, and within any ranges, established in the Conservation Measures. Any modifications to the parameters subject to real time operational adjustments or to the criteria and/or ranges set out in Table 3-1 shall occur only through the adaptive management.

Head of Old River gate. Operations for the Head of Old River gate would be managed under RTOs as follows.

- **October 1–November 30th:** RTO management in order to protect the D-1641 pulse flow designed to attract upstream migrating adults.
- **January:** When salmon fry are migrating (determined based on real time monitoring), initial operating criterion will be to close the gate subject to RTO for purposes of water quality, stage, and flood control considerations.
- **February–June 15th:** The gate will be closed, but subject to RTO for purposes of water quality, stage, and flood control considerations. The agencies will actively explore the implementation of reliable juvenile salmonid tracking technology which may enable shifting to a more flexible real time operating criterion based on the presence/absence of covered fishes.
- **June 16 to September 30, December:** Operable gates will be open.

North Delta diversions. Operations for North Delta bypass flows will be managed according to the following criteria:

- **October, November**: Flows will exceed 7,000 cfs.
- **July, August, September**: Flows will exceed 5,000 cfs.
- **December through June**: Post-pulse bypass flow operations will not exceed Level 1 pumping unless specific criteria have been met to increase to level 2 or level 3. If those criteria are met, operations can proceed as defined in Table 3-2[6]. The specific criteria for transitioning between and among pulse protection, Level 1, Level 2, and/or Level 3 operations, will be developed and based on real-time fish monitoring and hydrologic/behavioral cues upstream of and in the Delta. *<include specific transitioning criteria when available>*. During operations, adjustments are

[6] Consistent with Table 3.4.1-2 in the BDCP Public draft

expected to be made to improve water supply and/or migratory conditions for fish by making real-time adjustments to the pumping levels at the north Delta diversions. These adjustments would be managed under RTOs.

South Delta diversions. The south Delta diversions will be managed under RTO to achieve OMR criteria, as described in Section 3.2.3 and Table 3-1, throughout the year based on fish protection triggers (e.g., salvage density, calendar, species distribution, entrainment risk, turbidity, and flow based triggers [Table 3-3]). Increased restrictions as well as relaxations of the OMR criteria may occur as a result of observed physical and biological information. Additionally, as described above for the north Delta diversions, RTO would also be managed to distribute pumping activities among the three north Delta and two south Delta intake facilities to maximize both survival of covered fish species in the Delta and water supply.

Table 3-8. Salvage Density Triggers for Old and Middle River Flow Adjustments January 1 to June 15

First Stage Trigger

(1) Daily SWP/CVP older juvenile Chinook salmon[b] loss density (fish per TAF) is greater than incidental take limit divided by 2,000 (2% WR JPE ÷ 2,000), with a minimum value of 2.5 fish per taf, or

(2) Daily SWP/CVP older juvenile Chinook salmon loss is greater than 8 fish per TAF multiplied by volume exported (in TAF), or

(3) CNFH CWT LFR or LSNFH CWT WR cumulative loss is greater than 0.5% for each surrogate release group, or

(4) Daily loss of wild steelhead (intact adipose fin) is greater than 8 fish per TAF multiplied by volume exported (in TAF).[c]

Response:

- Reduce exports to achieve an average net OMR flow of -3,500 cfs for a minimum of 5 consecutive days. The 5-day running average OMR flows will be no more than 25% more negative than the targeted flow level at any time during the 5-day running average period (e.g., -4,375 cfs average over 5 days).
- Resumption of -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction.[c] Reductions are required when any one criterion is met.

Second Stage Trigger

(1) Daily SWP/CVP older juvenile Chinook salmon loss density (fish per TAF) is greater than incidental take limit (2% of WR JPE) divided by 1,000 (2% of WR JPE ÷ 1,000), with a minimum value of 2.5 fish per TAF, or

(2) Daily SWP/CVP older juvenile Chinook salmon loss is greater than 12 fish per TAF multiplied by volume exported (in TAF), or

(3) Daily loss of wild steelhead (intact adipose fin) is greater than 12 fish per TAF multiplied by volume exported (in TAF).

Response:

- Reduce exports to achieve an average net OMR flow of -2,500 cfs for a minimum 5 consecutive days. Resumption of -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction. Reductions are required when any one criterion is met.

End of Triggers

- Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier.

Response:

- If trigger for end of OMR regulation is met, then the restrictions on OMR are lifted.

[a] Salvage density triggers modify proposed action operations only within the ranges modeled. Triggers will not be implemented in a manner that reduces water supplies in amounts greater than modeled outcomes

[b] *Older juvenile Chinook salmon* is defined as any Chinook salmon that is above the minimum length for winter-run Chinook salmon, according to the Delta Model length-at-date table used to assign individuals to race.

[c] Three consecutive days in which the loss numbers are below the action triggers are required before the OMR flow reductions can be relaxed to -5,000 cfs. A minimum of 5 consecutive days of export reduction are required for the protection of listed salmonids under the action. Starting on day 3 of the export curtailment, the level of fish loss must be below the action triggers for the remainder of the 5-day export reduction to relax the OMR requirements on day 6. Any exceedance of a more conservative trigger restarts the 5-day OMR action response with the 3 consecutive days of loss monitoring criteria.

TAF = thousand acre-feet.

3.2.6 Timing for Implementation of Operations

Implementation of the proposed action will include operations of both new and existing water conveyance facilities as described in Table 3-1 and Section 3.2.1- 3.2.5 above, once the new north Delta facilities are completed and become operational, thereby enabling joint management of north and south Delta diversions. Until that time, operations will be implemented consistent with the NMFS (2009) and FWS (2008) BiOps, D-1641, as may be amended, and other regulatory and contractual obligations..

Table 3-8. Proposed Action CALSIM II Modeling Assumptions

Dual Conveyance Scenario with 9,000 cfs North Delta Diversion (includes Intakes 2, 3 and 5 with a maximum diversion capacity of 3,000 cfs at each intake)

1. North Delta Diversion Bypass Flows

Low-Level Pumping (Dec-Jun)

Diversions of up to 6% of total Sacramento River flow such that bypass flow never falls below 5,000 cfs. No more than 300 cfs can be diverted at any one intake.

Initial Pulse Protection

Low level pumping maintained through the initial pulse period. For the purpose of modeling, the initiation of the pulse is defined by the following criteria: (1) Wilkins Slough flow changing by more than 45% within a five day period and (2) flow on the fifth day greater than 12,000 cfs. Low-level pumping continues until either (1) Wilkins Slough flow returns to pre-pulse flows (flow on first day of 5-day increase), or (2) Wilkins Slough flows decrease for 5 consecutive days, or (3) Wilkins Slough flows are greater than 20,000 cfs for 10 consecutive days. After pulse period has ended, operations will return to the bypass flow table (Sub-Table A). These parameters are for modeling purposes. Actual operations will be based on real-time monitoring of hydrologic conditions and fish movement.

x These parameters are for modeling purposes. To be protective of present species, actual operations between pulses will be based on real-time monitoring of hydrologic conditions and fish movement.

Post-Pulse Operations

After initial pulse(s), go to Level I post-pulse bypass rule (see Sub-Table A) until 15 total days of bypass flows above 20,000 cfs. Then go to the Level II post-pulse bypass rule until 30 total days of bypass flows above 20,000 cfs. Then go to the Level III post-pulse bypass rule.

Sub-Table A. Post-Pulse Operations for North Delta Diversion Bypass Flows

Level I Post-Pulse Operations	Level II Post-Pulse Operations	Level III Post Pulse Operations
It is recommended to implement the following operating criteria: • Bypass flows sufficient to prevent upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough and (2) Sacramento River downstream of Georgiana Slough. These points are used to prevent upstream transport toward the proposed intakes and to prevent upstream transport into Georgiana Slough. **Dec - Apr**	It is recommended to implement the following operating criteria: • Bypass flows sufficient to prevent upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough and (2) Sacramento River downstream of Georgiana Slough. These points are used to prevent upstream transport toward the proposed intakes and to prevent upstream transport into Georgiana Slough.	It is recommended to implement the following operating criteria: • Bypass flows sufficient to prevent upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough and (2) Sacramento River downstream of Georgiana Slough. These points are used to prevent upstream transport toward the proposed intakes and to prevent upstream transport into Georgiana Slough.

If Sacramento River flow is over…	But not over…	The bypass is…	If Sacramento River flow is over…	But not over…	The bypass is…	If Sacramento River flow is over…	But not over…	The bypass is…
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 80% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 60% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 50% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,600 cfs plus 60% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	13,400 cfs plus 50% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	12,000 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	18,400 cfs plus 30% of the amount over 20,000 cfs	20,000 cfs	no limit	15,900 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	13,000 cfs plus 0% of the amount over 20,000 cfs

May

If Sacramento River flow is over…	But not over…	The bypass is…	If Sacramento River flow is over…	But not over…	The bypass is…	If Sacramento River flow is over…	But not over…	The bypass is…
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining	5,000 cfs	11,000 cfs	Flows remaining after	5,000 cfs	9,000 cfs	Flows remaining

		after constant low level pumping			constant low level pumping			after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 70% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 50% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 40% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,400 cfs plus 50% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	13,000 cfs plus 35% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	11,400 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	17,900 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	14,750 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	12,400 cfs plus 0% of the amount over 20,000 cfs
Jun								
If Sacramento River flow is over...	But not over...	The bypass is...	If Sacramento River flow is over...	But not over...	The bypass is...	If Sacramento River flow is over...	But not over...	The bypass is...
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 60% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 40% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 30% of the amount over 9,000 cfs

17,000 cfs	20,000 cfs	16,200 cfs plus 40% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	12,600 cfs plus 20% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	10,800 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	17,400 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	13,600 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	11,800 cfs plus 0% of the amount over 20,000 cfs
Jul - Sep								
If Sacramento River flow is over...	But not over...	The bypass is...	If Sacramento River flow is over...	But not over...	The bypass is...	If Sacramento River flow is over...	But not over...	The bypass is...
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	No limit	A minimum of 5000 cfs	5,000 cfs	No limit	A minimum of 5000 cfs	5,000 cfs	No limit	A minimum of 5000 cfs
Oct - Nov								
If Sacramento River flow is over...	But not over...	The bypass is...	If Sacramento River flow is over...	But not over...	The bypass is...	If Sacramento River flow is over...	But not over...	The bypass is...
0 cfs	7,000 cfs	100% of the amount over 0 cfs	0 cfs	7,000 cfs	100% of the amount over 0 cfs	0 cfs	7,000 cfs	100% of the amount over 0 cfs
7,000 cfs	No limit	A minimum of 7000 cfs	7,000 cfs	No limit	A minimum of 7000 cfs	7,000 cfs	No limit	A minimum of 7000 cfs

2. South Delta Channel Flows

OMR Flows

All of the baseline model logic and input used in the No Action Alternative as a surrogate for the OMR criteria required by the various fish protection triggers (density, calendar, and flow based triggers) described in FWS and NMFS OCAP BOs were incorporated into the modeling of the Proposed Action except for NMFS BO Action IV.2.1 – San Joaquin River i/e ratio, as well as these newly proposed operational criteria. Whenever those triggers require OMR be less negative or more positive than those shown below, the higher OMR requirements would be met. These newly proposed OMR criteria (and associated Head of Old River Barrier operations) are in response to expected changes under the Proposed Action, and only applicable after the proposed north Delta diversion becomes operational. Until the north Delta diversion becomes operational only the OMR criteria under the current BOs apply to CVP and SWP operations.

Combined Old and Middle River flows no less than values below[a] (cfs)
(Water year type classification based Sacramento River 40-30-30 index)

Month	W	AN	BN	D	C
Jan	0	-3500	-4000	-5000	-5000
Feb	0	-3500	-4000	-4000	-4000
Mar	0	0	-3500	-3500	-3000
Apr	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
May	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
Jun	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
Jul	N/A	N/A	N/A	N/A	N/A
Aug	N/A	N/A	N/A	N/A	N/A
Sep	N/A	N/A	N/A	N/A	N/A
Oct	varies[c]	varies[c]	varies[c]	varies[c]	varies[c]
Nov	varies[c]	varies[c]	varies[c]	varies[c]	varies[c]
Dec	-5000[d]	-5000[d]	-5000[d]	-5000[d]	-5000[d]

[a] Values are monthly averages for use in modeling. The model compares these minimum allowable OMR values to 2008 USFWS BiOp RPA OMR requirements and uses the less negative flow requirement.

[b] Based on San Joaquin inflow relationship to OMR provided below in Sub-Table B.

[c] Two weeks before the D-1641 pulse (assumed to occur October 16-31 in the modeling), No OMR restrictions (for modeling purposes an OMR requirement of -5,000 cfs was assumed during this 2 week period)
Two weeks during the D-1641 pulse, no south Delta exports
Two weeks after the D-1641 pulse, -5,000 cfs OMR requirement (through November)

[d] OMR restriction of -5,000 cfs for Sacramento River winter-run Chinook salmon when North Delta initial pulse flows are triggered or OMR restriction of -2,000 cfs for delta smelt when triggered.

Head of Old River Operable Barrier (HORB) Operations/Modeling assumptions (% OPEN)

MONTH	HORB[a]	MONTH	HORB[a]
Oct	50% (except during the pulse)[b]	May	50%
Nov	100% (except during the post-pulse period)[b]	Jun 1-15	50%
Dec	100%	Jun 16-30	100%
Jan	50%[c]	Jul	100%

Feb	50%	Aug	100%
Mar	50%	Sep	100%
April	50%		

[a] Percent of time the HORB is open. Agricultural barriers are in and operated consistent with current practices. HORB would be open 100% whenever flows are greater than 10,000 cfs at Vernalis.

Head of Old River Barrier operation is triggered based upon State Water Board D-1641 pulse trigger. For modeling assumptions only

Two weeks before the D-1641 pulse, it is assumed that the Head of Old River Barrier will be open 50%.

[b] During the D-1641 pulse (assumed to occur October 16-31 in the modeling), it is assumed the HORB will be closed.
For two weeks following the D-1641 pulse, it was assumed that the HORB will be open 50%
Exact timing of the action will be based on hydrologic conditions

[c] The HORB becomes operational at 50% when salmon fry are migrating (based on real time monitoring). This generally occurs when flood flow releases are being made. For the purposes of modeling, it was assumed that salmon fry are migrating starting on January 1.

In the CALSIM II modeling, the "HORB open percentage" specified above is modeled as the percent of time within a month that HORB is open. In the DSM2 modeling, HORB is assumed to operate such that the above-specified percent of "the flow that would have entered the Old River if the HORB were fully open", would enter the Old River.

Sub-Table B. San Joaquin Inflow Relationship to OMR

April and May		**June**	
If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (interpolated linearly between values)	If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (no interpolation)
≤ 5,000 cfs	-2,000 cfs	≤ 3,500 cfs	-3,500 cfs
6,000 cfs	+1,000 cfs	3,501 to 10,000 cfs	0 cfs
10,000 cfs	+2,000 cfs		
15,000 cfs	+3,000 cfs	10,001 to 15,000 cfs	+1,000 cfs
≥30,000 cfs	+6,000 cfs	>15,000 cfs	+2,000 cfs

3. Delta Cross Channel Gate Operations

Assumptions

Per SRWCB D-1641 with additional days closed from Oct 1 – Jan 31 based on NMFS BO (Jun 2009) Action IV.1.2 (closed during flushing flows from Oct 1 – Dec 14 unless adverse water quality conditions). This criteria is consistent with the No Action Alternative.

4. Rio Vista Minimum Instream Flows

Assumptions

Sep-Dec: Per D-1641; Jan-Aug: Minimum of 3,000 cfs

5. Delta Outflow

Delta Outflow

SWRCB D-1641 requirements, or outflow per requirements noted below, whichever is greater

Months	Delta Outflow Requirement
Spring (Mar-May):	Additional spring outflow requirement[a]
Fall (Sep-Nov):	Implement FWS BO Fall X2 requirement

Notes:
[a] Additional Delta Outflow required during the Mar-May period to maintain Delta outflows that would occur under the No Action Alternative at the time North Delta Diversion would become operational (for modeling purposes this is represented by the No Action Alternative model with projected climate (Q5) and sea level conditions at Early Long-Term). Mar-May average Delta outflow targets for the Proposed Action are tabulated below for 10% percent exceedances intervals based on the modeled No Action Alternative Mar-May Delta outflow. Since 2009 NMFS BO San Joaquin River i-e ratio constraint is the primary driver for the Apr-May Delta outflow under the No Action Alternative, this criteria was used to constrain Apr-May total Delta exports under the Proposed Action to meet Mar-May Delta outflow targets.

Percent Exceedance:	10%	20%	30%	40%	50%	60%	70%	80%	90%
Proposed Mar-May Delta Outflow Target (cfs)*:	44,500	44,500	35,000	27,900	20,700	16,800	13,500	11,500	9,100

* values based on the flow frequency of Mar – May average Delta Outflow modeled under No Action Alternative (January 27th, 2015 U.S. Bureau of Reclamation update) under Early Long-Term Q5 climate projections, without San Joaquin River Restoration Flows.

6. Operations for Delta Water Quality and Residence Time

Assumptions

Jul-Sep: Prefer south delta intake up to total pumping of 3,000 cfs; No specific intake preference beyond 3,000 cfs.

Oct-Jun: Prefer north delta intake;

(real-time operational flexibility)

7. In-Delta Agricultural and Municipal & Industrial Water Quality Requirements

Assumptions

Existing D-1641 AG and MI standards

8. D-1641 E-I Ratio Computation

Assumptions

Existing D-1641 E-I Ratio requirements

In computing the E-I Ratio in the CALSIM II model, the North Delta Diversion is not included in the export term, and the Sacramento River inflow is as modeled downstream of the North Delta Intakes.

3.3 Maintenance of the Facilities

The proposed action includes the maintenance of the new north Delta facilities (intakes, conveyance facilities, and appurtenance structures), the head of Old River barrier, and the south Delta facilities as described below.

3.3.1 North Delta Intakes

The proposed intake facilities (including intakes, pumping plants, sedimentation basins, and solids lagoons) would require scheduled routine or periodic adjustment and tuning to remain consistent with design intentions. Emergency maintenance is also anticipated. Routine facility maintenance would consist of activities such as painting, cleaning, repairs, and other tasks to operate facilities in accordance with design standards after construction and commissioning. It is anticipated that major equipment repairs and overhauls would be conducted at a centralized maintenance shop at one of the intake facilities sites or at the intermediate pumping plant site.

Routine visual inspection of the facilities would be conducted to monitor performance and prevent mechanical and structural failures of proposed action elements. Maintenance activities associated with river intakes could include removal of sediments, debris, and biofouling materials. These maintenance actions could require suction dredging or mechanical excavation around intake structures; dewatering; or use of underwater diving crews, boom trucks or rubber wheel cranes, and raft- or barge-mounted equipment. Periodic mussel cleaning in the sedimentation basins and solids removal from solids lagoons for off-site disposal would be required. Sediment in channels would also be removed periodically.

3.3.2 Conveyance Facilities

3.3.2.1 Tunnels

Maintenance requirements for the tunnels have not yet been finalized. Some of the critical considerations include evaluating whether the tunnels need to be taken out of service for inspection and, if so, how frequently. Typically, new water conveyance tunnels are inspected at least every 10 years for the first 50 years and more frequently thereafter. In addition, the equipment that the facility owner must put into the tunnel for maintenance needs to be assessed so that the size of the tunnel access structures can be finalized. Equipment such as trolleys, boats, harnesses, camera equipment, and communication equipment would need to be described prior to finalizing shaft design, as would ventilation requirements. As described above, it is anticipated that, following construction, large-diameter construction shafts would be modified to approximately 20-foot diameter access shafts.

At the time of preparation of this Biological Assessment, the use of remotely operated vehicles or autonomous underwater vehicles is being considered for routine inspection, reducing the number of dewatering events and reserving such efforts for necessary repairs.

3.3.3 Head of Old River Operable Barrier

For the operable barrier proposed under the proposed action, periodic maintenance of the gates would occur every 5 to 10 years. Maintenance of the motors, compressors, and control systems would occur annually and require a service truck. Maintenance dredging around the gate would be necessary to clear out sediment deposits. Dredging around the gates would be conducted using a sealed clamshell dredge. Depending on the rate of sedimentation, maintenance would occur every 3 to 5 years, removing no more than 25% of the original dredged amount, using a sealed clamshell dredge. Because of constraints related to fish and other species of concern, the timing and duration of maintenance dredging would be limited. Spoils would be dried in the areas adjacent to the gate site. A formal dredging plan with further details on specific maintenance dredging activities will be developed prior to dredging activities. Guidelines related to dredging activities, including compliance with in-water work windows and turbidity standards are described further in BDCP EIR/EIS Appendix 3B, *Environmental Commitments, under Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material*.

Some gates may not be required to operate for extended periods and would be operated at least two times per year. Each gate bay would be inspected annually at the end of the wet season for sediment accumulation. Sediment would be removed during the summer. Each miter or radial gate bay would include stop log guides and pockets for stop log posts to facilitate the dewatering of individual bays for inspection and maintenance. Major maintenance could require a temporary cofferdam upstream and downstream for dewatering.

3.3.4 Forebays

New forebays would be dredged to remove sediment and maintain design capacity. Maintenance requirements for the forebay embankments would include control of vegetation and rodents, embankment repairs in the event of island flooding and wind wave action, and monitoring of seepage flows. Maintenance of control structures could include roller gates, radial gates, and stop logs. Maintenance requirements for the spillway would include the removal and disposal of any debris blocking the outlet culverts. Dredging may be necessary to remove sediments in the forebays. As designed, both forebays are expected to have capacity to store sediment accumulated over a 50-year period. However, depending on the actual sedimentation rate, dredging may be necessary more or less often.

3.3.5 Connections to Banks and Jones Pumping Plants

Maintenance requirements for the canal would include erosion control, control of vegetation and rodents, embankment repairs in the event of island flooding and wind wave action, and monitoring of seepage flows. Sediment traps may be constructed by overexcavating portions of the channel upstream of the structures where the flow rate would be reduced to allow suspended sediment to settle at a controlled location. The sediment traps would be periodically dredged to remove the trapped sediment.

3.3.6 Power Supply and Grid Connections

Three utility grids could supply power to the proposed action conveyance facilities: Pacific Gas and Electric Company (PG&E) (under the control of the California Independent System Operator), the

Western Area Power Administration (Western), and/or the Sacramento Municipal Utility District (SMUD). The electrical power needed for the conveyance facilities would be procured in time to support construction and operation of the facilities. Purchased energy may be supplied by existing generation, or by new generation constructed to support the overall energy portfolio requirements of the western electric grid. It is unlikely that any new generation will be constructed solely to provide power to the proposed action conveyance facilities. It is anticipated the providers of the three utility grids which supply power to the proposed action would continue to maintain their facilities.

3.3.7 Existing South Delta Export Facilities

The proposed action would include maintenance and replacement of SWP and CVP facilities in the south Delta after the proposed intakes become operational and operations of new water facilities constructed as part of the proposed action.

Maintenance and replacement means those activities that maintain the capacity and operational features of the SWP and CVP water diversion and conveyance facilities described above. Maintenance activities include maintenance of electrical power supply facilities; maintenance as needed to ensure continued operations and replacement of facility or system components when necessary to maintain system capacity and operational capabilities; and upgrades and technological improvements of facilities to maintain system capacity and operational capabilities, improve system efficiencies, and reduce operations and maintenance costs.

3.4 Conservation Measures

Conservation measures are actions intended to minimize and offset effects on covered species, and to provide for their conservation and management. This section describes all of the proposed conservation measures. Table 3-4 summarizes required areas of species-specific restoration and protection, and identifies which conservation measures are relevant to each species.

The following conservation measures are included in the proposed action *(a full description of these measures is in contained in Draft BDCP Section 3.4)*:

- CM3 Natural Communities Protection and Restoration. This action would consist of the acquisition of lands for protection and restoration of habitat. This protection and restoration would mitigate for the loss of wildlife habitat associated with proposed construction. This measure is detailed below in Section 3.4.1.
- CM4 Tidal Habitat Restoration. This measure will create tidal wetlands. The measure will be implemented to compensate the loss of tidal wetlands that will occur during construction of north Delta intake facilities. This measure is detailed below in Section 3.4.2.
- CM6 Channel Margin Enhancement. This measure will recontour, vegetate, and otherwise modify existing leveed reaches of the Sacramento River in order to enhance their value as habitat for, primarily, migrating juvenile salmonids, although certain other species will benefit as well. This measure is intended to compensate for channel margins that will be lost or degraded during construction of the proposed intakes, and also to compensate for lost ecological function on existing restored benches that will occur as a hydraulic consequence of operations of the new and existing export facility operations. This measure is detailed below in Section

3.4.3.

- CM7 Riparian Natural Community Restoration. This measure will create riparian habitat at one or more sites within the Delta to compensate for construction effects on the riparian brush rabbit, least Bell's vireo, western yellow-billed cuckoo, and valley elderberry longhorn beetle. This measure is detailed below in Section 3.4.4.
- CM8 Grassland Natural Community Restoration. This measure will create grassland habitat at one or more sites within the Delta to compensate for construction effects on riparian brush rabbit and giant garter snake. This measure is detailed below in Section 3.4.5.
- CM9 Vernal Pool and Alkali Seasonal Wetland Complex Restoration. This measure will restore vernal pool and alkali seasonal wetland complex to address impacts on a variety of wildlife and rare plant species associated with proposed construction. This measure is detailed below in Section 3.4.6.
- CM10 Nontidal Marsh Restoration. This measure will restore nontidal marsh, to address impacts on giant garter snake associated with proposed construction. This measure is detailed below in Section 3.4.7.
- CM11 Natural Communities Enhancement and Management. All habitat restoration performed in conjunction with the conservation measures named above must be maintained in perpetuity. This measure describes the techniques that would be used to perform that maintenance. This measure is detailed below in Section 2.3.8.
- CM15 Localized Reduction of Predatory Fishes. This measure would perform predatory fish control in the vicinity of the proposed proposed intakes and in the vicinity of Clifton Court Forebay. This measure is intended to mitigate for incidental take of juvenile salmonids by reducing predation rates on these fish. This measure is detailed below in Section 3.4.9.
- Avoidance and minimization measures. These are measures that would be employed to minimize impacts to species during construction of the facilities. They are briefly described in Section 3.4.10 of this document, and fully detailed in Appendix X.

Table 3-9. Species Restoration and Protection Requirements and Relevant Conservation Measures.

Species and Habitat	Total Required Protection[a] (acres)	Total Required Restoration[a] (acres)	Notes	Relevant Conservation Measures
Chinook salmon (winter, spring run) and steelhead				
Habitat loss from North Delta Diversion (NDD)	-	160		Conservation Measure 3, Conservation Measure 4, Conservation Measure 11
Predation effects of operations	-	-	-	Conservation Measure 15
Effects on migration from NDD operations-channel margin and bench habitat	-	4.6 (linear miles)	-	Conservation Measure 3, Conservation Measure 6, Conservation Measure 11
Delta smelt				
Effects on entrainment, impingement, and productivity losses at intake locations for the SWP and CVP operations	-	160		Conservation Measure 3, Conservation Measure 4, Conservation Measure 11
Riparian brush rabbit				
Riparian habitat	(19)	(19)	Mitigation needs met by protection and restoration for least Bell's vireo.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Grassland habitat		227	Has unique grassland habitat type in south Delta adjacent to riparian areas. Supports vireo foraging habitat.	Conservation Measure 3, Conservation Measure 8, Conservation Measure 11
San Joaquin kit fox total				
	647	-		Conservation Measure 3, Conservation Measure 11
Least Bell's vireo				
	75	75	Overlaps with riparian brush rabbit and yellow-billed cuckoo habitat protection/restoration. Most will be accomplished in south Delta to maximize overlap.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Tricolored blackbird				

Breeding habitat-foraging	806		Overlaps with habitat needs for San Joaquin kit fox, California tiger salamander, and California red-legged frog.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Nonbreeding habitat-foraging	254		Assume protection in Yolo or Solano County. Protection of this habitat type has potential to benefit giant garter snake.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Swainson's hawk (nesting)	50	50	Protection and restoration of Swainson's hawk nesting has potential to benefit riparian brush rabbit, Least Bell's vireo, Western yellow-billed cuckoo, and Valley elderberry longhorn beetle.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Western yellow-billed cuckoo				
Breeding habitat	(12)	(12)	Overlaps with least Bell's vireo riparian protection/restoration.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Migratory habitat	(51)	(51)	Overlaps with least Bell's vireo riparian protection/restoration.	Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Giant garter snake				
Aquatic - tidal	-	(162)	Overlap with tidal restoration for salmonids.	Conservation Measure 3, Conservation Measure 4, Conservation Measure 11
Aquatic - nontidal	205	205	Protection of rice and restoration of nontidal wetland.	Conservation Measure 3, Conservation Measure 10, Conservation Measure 11
Upland-grassland		843		Conservation Measure 3, Conservation Measure 11
California red-legged frog				
Aquatic habitat	(5)		Entails protection and management of stock ponds on protected grasslands.	Conservation Measure 3, Conservation Measure 11
Upland cover and dispersal habitat	(68)	-	Overlaps with San Joaquin kit fox grassland protection.	Conservation Measure 3, Conservation Measure 11
Aquatic habitat (miles)	-	-		

California tiger salamander				
Aquatic breeding habitat	-	-	No impact would result from water facilities construction or operation, but CM9 will benefit the species.	Conservation Measure 3, Conservation Measure 9, Conservation Measure 11
Terrestrial cover and aestivation	(61)	-	Overlaps with San Joaquin kit fox grassland protection.	Conservation Measure 3, Conservation Measure 11
Valley elderberry longhorn beetle				
Riparian vegetation	(89)	(89)		Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Nonriparian channels and grasslands	-	148		Conservation Measure 3, Conservation Measure 7, Conservation Measure 11
Conservancy fairy shrimp				
Direct Effects				
Vernal pool complex	150	33		Conservation Measure 3, Conservation Measure 9, Conservation Measure 11
Longhorn fairy shrimp				
Vernal pool complex	(150)	(33)	Mitigation overlaps with vernal pool complex restoration for Conservancy fairy shrimp.	Conservation Measure 3, Conservation Measure 9, Conservation Measure 11
Vernal pool fairy shrimp				
Vernal pool complex	(150)	(33)	Mitigation overlaps with vernal pool complex restoration for Conservancy fairy shrimp.	Conservation Measure 3, Conservation Measure 9, Conservation Measure 11
Vernal pool tadpole shrimp				
Vernal pool complex	(150)	(33)	Mitigation overlaps with vernal pool complex restoration for Conservancy fairy shrimp.	Conservation Measure 3, Conservation Measure 9, Conservation Measure 11
Mason's lilaeopsis				

[a] Values in parentheses are protection or restoration that is provided by protection or restoration of other species. In other words, protection or restoration is "stacked" with other species and is not additive. See notes column for explanations.

Conservation measures CM3, CM4, CM6, CM7, CM9, CM10, and CM11 would be implemented to mitigate for all temporary and permanent effects on covered species habitat. Table 3-5 summarizes the requirement, based on known areas of impact and mitigation ratios, for protection or restoration of habitat for all covered species. Conservation measure CM15 does not entail land acquisition and protection; CM15 would be implemented in Sacramento River adjacent to the proposed intakes, and in Clifton Court Forebay.

Table 3-10. Required Protection/Restoration of Habitat for Covered Species as a Result of Construction, Maintenance, and Operation Impacts, by Conservation Measure.

Conservation Measure	Protection (ac)[a]	Restoration (ac)[a]	Conservation Zone[b]
CM4 Tidal Wetland	**0**	**162**	
Chinook salmon	0	160	CZ1, CZ2, CZ3
Delta smelt	0	160	
Giant garter snake	0	162	CZ1, CZ2, CZ3, CZ4, CZ5
CM6 Channel Margin Enhancement		**4.6 miles**	
Chinook salmon, Central Valley steelhead, and green sturgeon	0	4.6 miles	CZ3, CZ4, and CZ5
CM7 Riparian	**125**	**237**	
Least Bell's vireo	75	(75)	Anywhere in legal Delta.
Swainson's hawk[c]	50	(50)	Anywhere in legal Delta.
Riparian brush rabbit	(19)	(19)	CZ7
Western yellow-billed cuckoo (breeding)	(12)	(12)	Anywhere in legal Delta.
Western yellow-billed cuckoo (migratory)	(51)	(51)	Anywhere in legal Delta.
Valley elderberry longhorn beetle	(89)	237	Anywhere in legal Delta.
CM8 Grassland	**1,060**	**1,069**	
Tricolored blackbird (breeding habitat-foraging)[c]	806	-	CZ1, CZ2, CZ3, CZ4, CZ7, CZ8, CZ9
Tricolored blackbird (nonbreeding habitat-foraging)[c]	254	-	CZ3, CZ4, CZ5, CZ6, CZ7, CZ8, CZ9
California red-legged frog (upland cover and dispersal)	(68)	-	CZ8
California red-legged frog (aquatic)[d]	(4)	-	CZ8
California tiger salamander (terrestrial cover and aestivation)	(61)	-	CZ8
Giant garter snake	-	842	CZ4, CZ5
Riparian brush rabbit	-	227	CZ7
San Joaquin kit fox	(647)		CZ8
CM9 Vernal Pool/Alkali Seasonal Wetland Complex	**150**	**33**	
Conservancy fairy shrimp	150	33	CZ8
Longhorn fairy shrimp	(150)	(33)	CZ8
Vernal pool fairy shrimp	(150)	(33)	CZ8
Vernal pool tadpole shrimp	(150)	(33)	CZ8
CM10 Nontidal Wetland	**0**	**511**	

Giant garter snake[e]	0	510	CZ4, CZ5
California red-legged frog[f]	0	1	CZ8

Notes

[a] Number in parentheses indicates that the area of protection/restoration will be achieved due to the need to protect a larger or equal area of the same habitat type for the benefit of another species. All such parcels are required to be selected/maintained to meet the needs of all covered species dependent upon those parcels.

[b] Restoration may be sited in any one or more of the cited conservation zones. See Figure 3-54 for locations of conservation zones.

[c] Swainson's hawk and tricolored blackbird are not federally listed species. Reclamation does not seek any type of NMFS or USFWS determination for these species. They are included in this table because mitigation required under NEPA and CESA for impacts to those species results in habitat protection or restoration in excess of requirements for riparian- and grassland-associated federally listed species, thereby yielding a net beneficial effect on those federally listed species.

[d] Aquatic habitat protection for California red-logged frog result from the protection and management of ponds on grasslands protected for San Joaquin kit fox.

[e] Restoration of nontidal wetland habitat will expand upon the existing, protected wetlands in the White Slough/Caldoni Marsh area. The 842 acres of grassland will be adjacent to restored nontidal wetland habitat to provide upland cover.

[f] Two acres of aquatic habitat protection and management for California red-legged frog can substitute for one acre of restored aquatic habitat.

Implementation of all conservation measures will commence upon issuance of the biological opinion and record of decision for the proposed action. Acquisition of all lands to be used for habitat protection and restoration, and construction of such habitat, will be completed by the time the proposed intake and conveyance facilities become operational, approximately 14 years after proposed action approval. All conservation measures except CM15 will be implemented in perpetuity. Conservation measure CM15 will be implemented for the entire duration of operations of the proposed intake and conveyance facilities.

All conservation measures incorporate performance standards which will be tracked via monitoring at annual intervals. Annual monitoring reports will be provided to the Services.

3.4.1 CM3 Natural Communities Protection and Restoration.

Under *CM3 Natural Communities Protection and Restoration*, DWR will acquire lands for protection and restoration of covered species habitat. The habitat protection and restoration is intended to accomplish the following aims.

- Protect and enhance areas of existing habitat for covered species.
- Provide sites suitable for restoration of covered species habitat. Some restoration could occur on lands already publicly owned.
- Provide habitat connectivity to existing conservation lands.

Because it merely describes procedures for land acquisition, CM3 implementation is not expected to either harm or benefit any of the covered species. Land acquisition is a necessary precursor to implementation of CM4, CM6, CM7, CM9, CM10, and CM11.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.2 CM4 Tidal Habitat Restoration

Under CM4 Tidal Habitat Restoration, DWR will restore tidal habitat to mitigate for loss of 160 acres of tidal habitat, associated with construction of proposed facilities in the north Delta. The land acquisition is expected to occur on a currently undetermined site in the Cache Slough area. As such, the proposed restoration will convert 160 acres of agricultural land to tidal wetland. Of the covered species, only the giant garter snake has a primary association with cultivated land. The mitigation site will be selected to avoid effects on giant garter snake. Restoration of tidal habitat via CM4 may cause minor and localized incidental take due to activities such as construction area isolation by temporary cofferdam placement (which has the potential to harm covered fish present in the work area) and construction-associated noise and activity (which has the potential to cause behavioral responses in covered wildlife present in the vicinity), effects which will be minimized using avoidance and minimization measures described in Section 3.4.10. The proposed mitigation will primarily benefit delta and longfin smelt, both of which forage extensively in the Cache Slough area. Lesser benefits may accrue to juvenile green sturgeon, Chinook salmon, and steelhead.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.3 CM6 Channel Margin Enhancement

Under CM6 Channel Margin Enhancement, DWR will restore channel margins along the Sacramento River in the general vicinity of the proposed intakes. Restoration sites have not been selected but it is likely that some will be upstream of the proposed intakes, some downstream, and some on the opposite bank within the intake reach. This restoration is intended to mitigate for two impacts. First is the impact to channel margin habitat that will occur due to construction of the proposed intakes. This impact will affect approximately 2.6 linear miles of channel margin. Second is the impact that will occur because reduced flows in the Sacramento River below the intakes will reduce the ecological functionality of channel margin habitat that has previously been constructed, in connection with unrelated, prior restoration and mitigation projects. This impact is expected to affect approximately 9 linear miles of channel margin, and to reduce inundation of the affected sites by approximately 20% over the long term. CM6 will restore approximately 4.6 linear miles of channel margin. Construction of channel margin restoration via CM6 may cause minor and localized incidental take due to activities such as construction area isolation by temporary cofferdam placement (which has the potential to harm covered fish present in the work area) and construction-associated noise and activity (which has the potential to cause behavioral responses in covered wildlife present in the vicinity), effects which will be minimized using avoidance and minimization measures described in Section 3.4.10. Implementation of CM6 will principally benefit covered fish found in the restoration areas, chiefly salmonids. Benefits will also accrue to the few smelt that may occur in the restoration areas, and to riparian-associated species that may use the riparian habitat created by plantings along enhanced channel margins.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.4 CM7 Riparian Natural Community Restoration

Under CM7 Riparian Natural Community Habitat Restoration, DWR will restore riparian habitat to mitigate for loss of habitat, associated with construction of proposed facilities. At least 19 acres of riparian protection or restoration will occur in CZ7 adjacent to or near riparian brush rabbit occupied habitat. The remaining riparian protection or restoration can occur on suitable sites anywhere in the legal Delta, as least Bell's vireo, western yellow-billed cuckoo, and valley elderberry longhorn beetle have ranges that include the entire area. The proposed restoration will convert 273 acres of agricultural land to riparian natural community. The construction will result in loss of habitat and likely incidental take of Valley elderberry longhorned beetle, loss of habitat and potential incidental take of western yellow-billed cuckoo, and loss of modeled but unoccupied habitat of riparian brush rabbit. Of the covered species, only the giant garter snake has a primary association with cultivated land. Mitigation sites will be selected to avoid effects on giant garter snake.

Note that the restoration commitment of 125 acres of protection and 237 acres of restoration (Table 3-5) exceeds the required habitat protection offset for riparian brush rabbit and western yellow-billed cuckoo, and exceed the required habitat restoration offset for least Bell's vireo, riparian brush rabbit, and western yellow-billed cuckoo. Thus the proposed restoration and protection result in a net increase in available habitat for these species, over and above any increase provided due to mitigation ratios.

Restoration of riparian habitat via CM7 may cause minor and localized incidental take due to construction-associated noise and activity, which has the potential to cause behavioral responses in covered wildlife present in the vicinity, and which will be minimized using avoidance and minimization measures described in Section 3.4.10. The proposed mitigation will primarily benefit Valley elderberry longhorned beetle and western yellow-billed cuckoo, by providing foraging and breeding habitat for both species. Lesser benefits may accrue to riparian brush rabbit, which may occupy restored habitat at some future time, and least Bell's vireo, which is not now known to occur .

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.5 CM8 Grassland Natural Community Restoration

Under CM8 Grassland Natural Community Habitat Restoration, DWR will restore grassland habitat to mitigate for loss of habitat associated with construction of proposed facilities. The land acquisition is expected to occur in CZ 7 for restoration actions associated with riparian brush rabbit and in CZs 4 and 5 for restoration actions associated with giant garter snake. As such, the proposed restoration will convert 907 acres of cultivated land to grassland natural community. The construction will result in loss of grassland habitat and potential incidental take of giant garter snake and in loss of modeled grassland habitat for riparian brush rabbit. Of the covered species, only the giant garter snake has a primary association with cultivated land. Mitigation sites will be selected to avoid effects on giant garter snake.

Note that the restoration commitment of 1,060 acres of protection and 1,069 acres of restoration (Table 3-5) exceeds the required habitat protection offset for riparian brush rabbit, California red-legged frog, giant garter snake, and California tiger salamander, and exceeds the required habitat restoration offset for San Joaquin kit fox, California red-legged frog, and California tiger salamander (however there is no overlap between suitable grassland habitat for riparian brush rabbit and giant garter snake, so these two species will be addressed at separate restoration sites). Thus the proposed restoration and protection result in a net increase in available habitat for the frog, salamander, garter snake, and kit fox, over and above any increase provided due to mitigation ratios.

Restoration of grassland habitat via CM8 may cause minor and localized incidental take due to construction-associated noise and activity, which has the potential to cause behavioral responses in covered wildlife present in the vicinity, and which will be minimized using avoidance and minimization measures described in Section 3.4.10. The proposed mitigation will primarily benefit giant garter snake, by providing areas of grassland habitat. Lesser benefits may accrue to riparian brush rabbit, which may occupy restored habitat at some future time.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.6 CM9 Vernal Pool and Alkali Seasonal Wetland Complex Restoration

Under CM9 Vernal Pool and Alkali Seasonal Wetland Complex Restoration, DWR will restore vernal pools and alkali seasonal wetland complex to mitigate for loss of habitat, primarily associated with construction of proposed facilities just east of the Clifton Court Forebay. The land acquisition is expected to occur in CZ 8. Although the proposed action will convert cultivated lands or grasslands to vernal pool complex and alkali seasonal wetland natural community, this is not considered a loss of habitat to the covered species that use these habitats (San Joaquin kit fox, California tiger salamander, and California red-legged frog), but a conversion of habitat types. This is because these three species can use grasslands, cultivated lands, vernal pools, and alkali seasonal wetlands interchangeably, though protected and managed natural habitats are considered to be higher quality than cultivated lands such as pasture lands. Conveyance construction will result in loss of habitat and likely incidental take of Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

Restoration of vernal pool and alkali season wetland via CM9 may cause minor and localized incidental take due to construction-associated noise and activity, which has the potential to cause behavioral responses in covered wildlife, particularly kit fox, if present in the vicinity. These effects will be minimized using avoidance and minimization measures described in Section 3.4.10. The proposed mitigation will primarily benefit Conservancy fairy shrimp, Longhorn fairy shrimp, Vernal pool fairy shrimp, and Vernal pool tadpole shrimp, by providing habitat necessary for the complete life cycle of each species. Lesser benefits may accrue to San Joaquin kit fox, California tiger salamander, and California red-legged frog, which will realize higher habitat quality due to the conversion of pasture lands to vernal pool and alkali seasonal wetland complex.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.7 CM10 Nontidal Marsh Restoration

Under CM10 Nontidal Marsh Restoration, DWR will restore nontidal marsh habitat to mitigate for loss of habitat associated with construction of proposed facilities in the north Delta. The land acquisition is expected to occur in CZ4 and CZ5 on lands adjacent to, or connected with, protected lands in the the White Slough/Caldoni Marsh complex. Siting criteria to be used in evaluating candidate restoration sites include:

- connectivity to protected lands comprised of nontidal wetlands or rice in or near the White Slough/Caldoni Marsh complex;
- mitigation sites will be protected from risk of incidental injury or mortality by establishing 200-foot buffers between protected giant garter snake habitat and roads (other than those roads primarily used to support adjacent cultivated lands and levees); and
- giant garter snake mitigation lands will be sited at least 2,500 feet from urban areas or areas

zoned for urban development.

The proposed restoration will protect 205 acres of cultivated land (rice) and restore 205 acres of nontidal marsh. The construction will result in loss of habitat and likely incidental take of giant garter snake. Restoration of nontidal marsh via CM10 may cause minor and localized incidental take due to construction-associated noise and activity, which has the potential to cause behavioral responses in covered wildlife present in the vicinity, and which will be minimized using avoidance and minimization measures described in Section 3.4.10. The proposed mitigation will primarily benefit giant garter snake.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.8 CM11 Natural Communities Enhancement and Management

Under CM11 Natural Communities Enhancement and Management, DWR will manage in perpetuity all habitat preserved or restored pursuant to conservation commitments expressed in this biological assessment, totaling 2,884 acres. Management activities include monitoring to track restoration lands compliance with performance standards, may include control of undesirable plants and animals, and also include such other activities as may be found necessary to meet the established performance standards for each protected or restored habitat type.

These management activities have the potential to result in short-term, localized adverse modification of covered species habitat, and also have the potential to result in injury, mortality, and harassment in association with the noise and activity associated with performance of the management activities, which will be minimized using avoidance and minimization measures described in Section 3.4.10. The proposed management activities will ensure perpetuation of the beneficial effects on covered species achieved by initial habitat preservation and restoration.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.9 CM15 Localized Reduction of Predatory Fishes

Under CM15 Localized Reduction of Predatory Fishes, DWR will perform activities to reduce the abundance of predatory nonnative fishes in the Sacramento River near the proposed intakes, and in and near existing and proposed facilities in the vicinity of Clifton Court Forebay. This action is intended to mitigate for any elevated rates of predation that may have occurred in response to construction and operation of these facilities (CM15 includes baseline studies to assess preconstruction predation rates in the Sacramento River, but analogous data are not available for Clifton Court Forebay). Performance of the conservation measure will occur in close coordination with and subject to approval by NMFS staff.

Activities performed under CM15 may cause minor and localized incidental take due to in-water activities, incidental catch of non-target species, and ecological effects such as altered size distribution and density of predators, which may alter their prey selection behavior. The proposed mitigation will primarily benefit juvenile salmonids and sturgeons, both of which are currently subject to heavy predation during their passage through the Delta.

[Note, revised language to be provided prior to Admin Draft BA.]

3.4.10 Avoidance and Minimization Measures

[Note, revised language to be provided prior to Admin Draft BA.]

Avoidance and minimization measures (AMMs) that would be implemented during construction and maintenance/management of proposed water facilities and performance of conservation measures are summarized in Table 3-6 and fully detailed in Appendix X, *Avoidance and Minimization Measures (a full description is currently available in Draft BDCP Appendix 3.C)*.

3.4.10.1 Phases of Avoidance and Minimization Actions

Specific AMMs have been developed that will be implemented for each component of the proposed action. Identification and implementation of the appropriate AMMs for each component will occur in four phases.

- **Planning-level surveys and proposed action planning.** Site-specific surveys will be conducted during the proposed action planning phase to identify covered species habitat and covered species to which AMMs apply. The proposed action will be designed to avoid and minimize impacts based on information developed during the planning-level surveys.
- **Preconstruction surveys.** Biological surveys will occur prior to proposed action construction, depending on the results of the planning surveys. Results of the planning surveys will be used to determine which AMMs will be applied prior to or during construction.
- **Proposed action construction.** Many AMMs will be implemented during proposed action construction. For some activities, a biological monitor will be present to ensure that the measures are effectively implemented. For some species (e.g., California red-legged frog), the biological monitor will relocate individuals from the construction area to specified nearby safe locations.
- **Proposed action operation and maintenance.** Some of the AMMs apply to long-term operation and maintenance activities, such as operation and maintenance of the water conveyance facilities (performed for the duration of the proposed action) and ongoing covered species' habitat enhancement and management (performed in perpetuity).

Table 3-11. Summary of the Avoidance and Minimization Measures.

Number	Title	Summary
Benefit All Natural Communities and Covered Species		
AMM1	Worker Awareness Training	Includes procedures and training requirements to educate construction personnel on the types of sensitive resources in the action area, the applicable environmental rules and regulations, and the measures required to avoid and minimize effects on these resources.
AMM2	Construction Best Management Practices and Monitoring	Standard practices and measures that will be implemented prior, during, and after construction to avoid or minimize effects of construction activities on sensitive resources (e.g., species, habitat), and monitoring protocols for verifying the protection provided by the implemented measures.
Primarily Benefit Covered Fishes		

AMM3	Stormwater Pollution Prevention Plan	Includes measures that will be implemented to minimize pollutants in stormwater discharges during and after construction related to covered activities, and that will be incorporated into a stormwater pollution prevention plan to prevent water quality degradation related to pollutant delivery from action area runoff to receiving waters.
AMM4	Erosion and Sediment Control Plan	Includes measures that will be implemented for ground-disturbing activities to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities, and that will be incorporated into plans developed and implemented as part of the National Pollutant Discharge Elimination System permitting process for covered activities.
AMM5	Spill Prevention, Containment, and Countermeasure Plan	Includes measures to prevent and respond to spills of hazardous material that could affect navigable waters, including actions used to prevent spills, as well as specifying actions that will be taken should any spills occur, and emergency notification procedures.
AMM6	Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material	Includes measures for handling, storage, beneficial reuse, and disposal of excavation or dredge spoils and reusable tunnel material, including procedures for the chemical characterization of this material or the decant water to comply with permit requirements, and reducing potential effects on aquatic habitat, as well as specific measures to avoid and minimize effects on species in the areas where reusable tunnel material would be used or disposed.
AMM7	Barge Operations Plan	Includes measures to avoid or minimize effects on aquatic species and habitat related to barge operations, by establishing specific protocols for the operation of all action-related vessels at the construction and/or barge landing sites. Also includes monitoring protocols to verify compliance with the plan and procedures for contingency plans.
AMM8	Fish Rescue and Salvage Plan	Includes measures that detail procedures for fish rescue and salvage to avoid and minimize the number of Chinook salmon, steelhead, green sturgeon, and other covered fish stranded during construction activities, especially during the placement and removal of cofferdams at the intake construction sites.
AMM9	Underwater Sound Control and Abatement Plan	Includes measures to minimize the effects of underwater construction noise on fish, particularly from impact pile–driving activities. Potential effects of pile driving will be minimized by restricting work to the least sensitive period of the year and by controlling or abating underwater noise generated during pile driving.
Primarily Benefit Covered Plants, Wildlife, or Natural Communities		
AMM10	Restoration of Temporarily Affected Natural Communities	Restore and monitor natural communities in the Plan Area that are temporarily affected by covered activities. Measures will be incorporated into restoration and monitoring plans and will include methods for stockpiling and storing topsoil, restoring soil conditions, and revegetating disturbed areas; schedules for monitoring and maintenance; strategies for adaptive management; reporting requirements; and success criteria.
AMM11	Covered Plant Species	Conduct botanical surveys during the proposed action planning phase and implement protective measures, as necessary. Redesign to avoid indirect effects on modeled habitat and effects on core recovery areas.
AMM12	Vernal Pool Crustaceans	Includes provisions to require proposed action design to minimize indirect effects on modeled habitat, avoid effects on core recovery areas, minimize ground-disturbing activities or alterations to hydrology, conduct protocol-level surveys, and redesign the proposed action to ensure that no suitable habitat is within these areas.
AMM13	California Tiger Salamander	During the proposed action planning phase, identify suitable habitat within 1.3 miles of the footprint and survey aquatic habitats in potential work areas for California tiger salamander. If California tiger salamander larvae or eggs are found, implement prescribed avoidance and minimization measures/.

AMM14	California Red-Legged Frog	During the proposed action planning phase, identify suitable habitat within 1 mile of the footprint, conduct a preconstruction survey, implement protective measures for areas where species presence is known or assumed, and establish appropriate buffer distances. If aquatic habitat cannot be avoided, implement prescribed avoidance and minimization measures.
AMM15	Valley Elderberry Longhorn Beetle	During the proposed action planning phase, conduct surveys for elderberry shrubs within 100 feet of covered activities involving ground disturbance, and design the proposed action to avoid effects within 100 feet of shrubs, if feasible. Implement additional protective measures, as stipulated in AMM2. Elderberry shrubs identified within footprints that cannot be avoided will be transplanted to previously approved conservation areas.
AMM16	Giant Garter Snake	During the proposed action planning phase, identify suitable aquatic habitat (wetlands, ditches, canals) in the footprint. Conduct preconstruction surveys and implement protective measures.
AMM22	Least Bell's Vireo, Western Yellow-Billed Cuckoo	Conduct preconstruction surveys of potential breeding habitat in and within 500 feet of proposed action construction activities. It may be necessary to conduct the breeding bird surveys during the preceding year depending on when construction is scheduled to start. Implement protective measures in occupied areas.
AMM23	San Joaquin Kit Fox	Conduct habitat assessment in and within 250 feet of proposed action footprint. If suitable habitat is present, conduct a preconstruction survey and implement U.S. Fish and Wildlife Service guidelines. Implement protective measures in occupied areas.
AMM24	Riparian Brush Rabbit	Conduct surveys for components of the proposed action occurring within suitable habitat as identified from habitat modeling and by additional assessments conducted during the planning phase of construction or restoration projects following U.S. Fish and Wildlife Service *Draft Habitat Assessment Guidelines and Survey Protocol for the Riparian Brush Rabbit and the Riparian Woodrat*. Implement protective measures in suitable habitat.
AMM25	Georgiana Slough non-physical barrier	Annually install, operate, and monitor performance of a non-physical barrier at the entrance to Georgiana Slough.
AMM26	Mercury Management	Develop and implement a plan to evaluate site-specific restoration conditions and include design elements that minimize any conditions that could be conducive to increases of bioavailable mercury (methylmercury) in restored areas. Before ground-breaking activities associated with site-specific restoration occurs, identify and evaluate potentially feasible actions for the purpose of minimizing conditions that promote increases in methylmercury in restored areas.
AMM27	Selenium Management	Develop and implement a plan to evaluate site-specific restoration conditions and include design elements that minimize any conditions that could be conducive to increases of bioavailable selenium in restored areas. Before ground-breaking activities associated with site-specific restoration occurs, identify and evaluate potentially feasible actions for the purpose of minimizing conditions that promote bioaccumulation of selenium in restored areas.
AMM28	Geotechnical Studies	Conduct geotechnical investigations to identify the types of soil avoidance or soil stabilization measures that should be implemented to ensure that the facilities are constructed to withstand subsidence and settlement and to conform to applicable state and federal standards.
AMM29	Design Standards and Building Codes	Ensure that the standards, guidelines, and codes, which establish minimum design criteria and construction requirements for proposed action facilities, will be followed. Follow any other standards, guidelines, and code requirements that are promulgated during the detailed design and construction phases and during operation of the conveyance facilities.

AMM30	Transmission Line Design and Alignment Guidelines	Design the alignment of proposed transmission lines to minimize impacts on sensitive terrestrial and aquatic habitats when siting poles and towers. Restore disturbed areas to preconstruction conditions. In agricultural areas, implement additional BMPs. Site transmission lines to avoid greater sandhill crane roost sites or, for temporary roost sites, by relocating roost sites prior to construction if needed. Site transmission lines to minimize bird strike risk.
AMM31	Noise Abatement	Develop and implement a plan to avoid or reduce the potential in-air noise impacts related to construction, maintenance, and operations.
AMM32	Hazardous Material Management	Develop and implement site-specific plans that will provide detailed information on the types of hazardous materials used or stored at all sites associated with the water conveyance facilities and required emergency-response procedures in case of a spill. Before construction activities begin, establish a specific protocol for the proper handling and disposal of hazardous materials.
AMM33	Mosquito Management	Consult with appropriate mosquito and vector control districts before the sedimentation basins, solids lagoons, and the intermediate forebay inundation area become operational. Once these components are operational, consult again with the control districts to determine if mosquitoes are present in these facilities, and implement mosquito control techniques as applicable. Consult with the control districts when designing and planning restoration sites.
AMM34	Construction Site Security	Provide all security personnel with environmental training similar to that of onsite construction workers, so that they understand the environmental conditions and issues associated with the various areas for which they are responsible at a given time.
AMM35	Fugitive Dust Control	Implement basic and enhanced control measures at all construction and staging areas to reduce construction-related fugitive dust and ensure the proposed action commitments are appropriately implemented before and during construction, and that proper documentation procedures are followed.
AMM36	Notification of Activities in Waterways	Before in-water construction or maintenance activities begin, notify appropriate agency representatives when these activities could affect water quality or aquatic species.
Further AMMs to avoid FPS		

In addition to the avoidance and minimization measures cited above, which would apply prior to and during construction and maintenance of water conveyance facilities and restoration sites, water operations as described in Section 3.2 above have also been designed to minimize and avoid incidental take of covered fish species. Aspects of water operations that are specifically intended to minimize incidental take risk include the following.

- Bypass flows at the proposed intakes are intended to minimize the risk of increased predation during downstream migration by limiting changes in water velocity and by limiting the risk of entering the interior Delta as a consequence of increased tidal influence at the Sacramento River-Georgiana Slough divergence.
- South Delta export operations are constrained to minimize reverse flows in the Old and Middle Rivers, especially at times of the year when covered fish abundances in these and nearby waters are relatively high. This reduces the risks of entrainment and predation in Old River and adjacent waterways, and the south Delta export facilities, as well as indirect effects caused by changes in hydrodynamics in the interior Delta.

- The Head of Old River Gate operations are timed to minimize the risk that covered species migrating down the San Joaquin River may enter Old River, thereby supporting improved survival on the San Joaquin River migratory route. These operations are managed to be consistent with applicable water quality regulations, to avoid flooding risk, and to limit entrainment potential for fish that may be in the central Delta near the downstream ends of Old and Middle Rivers.
- The Rio Vista minimum flow standard is intended to maintain minimum flows for outmigrating salmonids and smelt.
- A real-time operations procedure is adopted that will be used to manage and adjust bypass flows, south Delta export operations, and Head of Old River Gate operations to optimize fish survival probabilities and habitat quality, consistent with overall operations criteria.

A detailed analysis of the expected effects of these measures on covered species is presented in Chapter 5.

3.4.11 Adaptive Management

This subsection would describe the adaptive management program being proposed to address uncertainty and provide a process for improving the proposed action over time.

3.4.12 Monitoring Program

This subsection would describe the monitoring that will be proposed to address uncertainties described in the adaptive management program as well as other effects and compliance monitoring being proposed.

3.4.13 Research Program

This subsection would describe the research activities proposed to address areas of scientific uncertainty in support of the adaptive management program.

3.5 Interrelated or Interdependent Actions

This section would describe any actions that are interrelated or interdependent with the proposed action. Interrelated actions are defined as actions that are part of a larger action and depend on the larger action for their justification. Interdependent actions are defined as actions that have no independent utility apart from the action being reviewed in the Section 7 consultation. It is expected that this section would indicate that no interrelated or interdependent actions have been identified.

3.6 References

Blue highlight – Author provided a reference that is not mentioned in the text.

Anderson, J. J., J. A. Gore, R. T. Kneib, M. S. Lorang, J. M. Nestler, and J. Van Sickle. 2012. *Report of the 2012 Delta Science Program Independent Review Panel (IRP) on the Long-term Operations Opinions (LOO) Annual Review*. December 1.

California Department of Water Resources. 2014. *Geotechnical Exploration Plan—Phase 2.* Delta Habitat Conservation and Conveyance Program. Revision 3. June. Sacramento, CA.

Delta Stewardship Council. 2010. *Fall Low Salinity Habitat (FLaSH) Studies and Adaptive Management Plan Review*. Available: <http://deltacouncil.ca.gov/science-program/fall-low-salinity-habitat-flash-studies-and-adaptive-management-plan-review-0>. Accessed: November 6, 2012.

Fish Facilities Technical Team 2011. Technical Memorandum. Bay Delta Conservation Plan.

National Marine Fisheries Service. 2009. *Biological Opinion and Conference Opinion on the Long-term 28 Operations of the Central Valley Project and State Water Project*. June. Southwest Region, Long Beach, CA.

National Marine Fisheries Service. 2011. *2011 Amendments to the NMFS OCAP RPA*. April 7. Available: <http://swr.nmfs.noaa.gov/ocap.htm>. Southwest Region, Long Beach, CA.

Svoboda, C. 2013. Scoping Paper: investigation of Fish Refugia Concepts at Hydraulic Structures. Bureau of Reclamation, Denver, CO.

Swanson, C., Young, P. S., & Cech Jr, J. J. (2005). Close encounters with a fish screen: integrating physiological and behavioral results to protect endangered species in exploited ecosystems. *Transactions of the American Fisheries Society*, *134*(5), 1111-1123.

URS. 2014. *Reusable Tunnel Material Testing Report*. Prepared for State of California Department of Water Resources. Sacramento, CA. Available: http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Reusable_Tunnel_Material_Testing_Report.sflb.ashx.

U.S. Fish and Wildlife Service. 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP). Biological opinion. December. Sacramento, CA. Available: http://www.fws.gov/sfbaydelta/cvp-swp/cvp-swp.cfm.

White, D. K., Swanson, C., Young, P. S., Cech Jr, J. J., Chen, Z. Q., & Kavvas, M. L. (2007). Close encounters with a fish screen II: Delta smelt behavior before and during screen contact. *Transactions of the American Fisheries Society*, *136*(2), 528-538.

FOR PUBLICATION USE ONLY

Contents detailed

Tables

Acronyms

Citations